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COMPUTER ABSTRACTS

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GENERAL

1807 **General problems confronting computing centers.** R. Courant, *Ordinary Differential Equations Proc.**, 1960, 672-676. This paper appeared in *Bull. Provisional Int. Computation Centre*, Jan. 1961, 10-13; for abstract see *C.A.*, **5**, March 1961, Ref. 415.

1808 **Logic-structure tables.** H. N. Cantrell, J. King and F. E. H. King, *Commun. ACM*, **4**, June 1961, 272-275. A set of rules for writing and using logic tables is explained by means of some simple examples. Then, using two logic tables, the logic involved in the operation of a vending machine is presented. It is pointed out that logic tables are two-dimensional in nature enabling both the sequential and parallel aspects of logic to be fully expressed and considered. Logic tables are an excellent way of developing and expressing the logic required in procedures, operations, systems and circuits. They can be compiled directly into a computer program and so eliminate the need for flow charting and hand coding. 1 ref.

1809 **A logical machine for measuring problem solving ability.** C. R. Langmuir, *Proc. Eastern Joint Computer Conference*, 1960, 1-9. This paper describes a small desk-top machine called the Logical Analysis Device, its use in testing a person's ability to manipulate logical concepts and solve logical problems, and its application to the selection of personnel for digital computer design and programming tasks. The device consists of nine lights each of which can be switched on by an associated push-button switch. The operation of the device is controlled by an indicator light showing the passage of time in alternating intervals and each switch is effective in one but not the other interval. An information diagram shows arrows connecting lights to other lights and also to a target light (without a switch). The meaning of each arrow is not shown; it may indicate cause-and-effect (i.e. turning on of one light may cause, *during the next interval*, turning on of the light to which the arrow connects it) or two arrows converging on one light may require simultaneous actuation of the lights at which the arrows initiate or an arrow may indicate a preventive action. The person being tested is presented, after careful instruction, with the problem of determining how to manipulate a specified three of the switches so as to actuate the target light. Tests of varying difficulty may be set up by altering the information diagram. Experimental results obtained with this device are discussed at some length.

1810 **The state of digital computer technology in Europe.** N. M. Blachman, *Commun. ACM*, **4**, June 1961, 256-265. This report indicates the level of computer development and application in each of the thirty countries of Europe, particular attention being paid to those countries whose work in the computer field is less well known. 3 refs.

1811 **Theory of abstract machines.** S. Ginsburg, *Commun. ACM*, **4**, April 1961, 195. Brief account of a project at System Development Corporation with the purpose of studying, from a mathematical viewpoint, the flow of information in a computing system from the initial inputs to the final outputs. 3 refs.

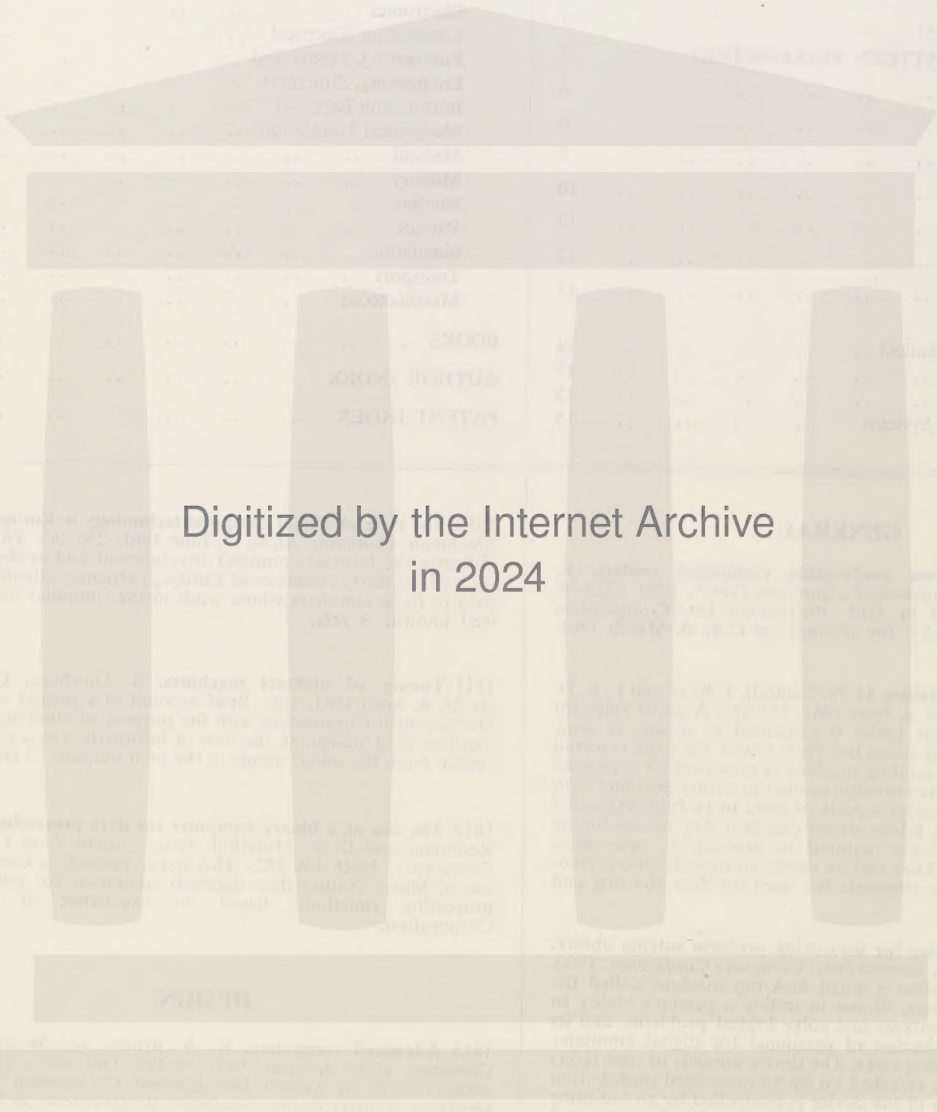
1812 **The use of a binary computer for data processing.** G. H. Redmond and D. E. Mulvihill, *Proc. Eastern Joint Computer Conference*, 1960, 149-152. This paper presents a case for the use of binary (rather than decimal) computers for purely data processing functions, based on experience at Chrysler Corporation.

DESIGN

1813 **Advanced computers.** R. A. Brouse and W. Shooman, *Commun. ACM*, **4**, April 1961, 194-195. This note is concerned with research at System Development Corporation with the objective of investigating significant developments in advanced computers and exploring the relationship between programming and new concepts of computer organisation. Two studies in progress are briefly described: data sequencing based on the concept that the flow of data through a program is the basic determiner of sequence; and vertical data processing, a technique for the simultaneous manipulation of multiple data on digital computers. 2 refs.

1814 **Boolean rings.** G. H. Mealy, *Commun. ACM*, **4**, May 1961, 250. Letter reviewing the basic facts concerning Boolean rings.

* For full title see Ref. 2103.



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315 **Data processing techniques in design automation.** W. L. ordon, *Proc. Eastern Joint Computer Conference,* 1960, 205-09. It is suggested that the automation of the design of a com-lex system (such as a computer) is primarily a data processing roblem in which the most powerful tools reside in the ability f the data processor to perform such jobs as editing, extracting, rting and merging pieces of basic design information. This ntention is substantiated by outlining the Design Automation ystem, employing a D-1000 data processor, in successful use at ne Electronic Data Processing Division of Minneapolis-Honey-ell Regulator Company.

816 **Impact of automation on digital computer design.** W. A. Iannig and T. L. Mayes, *Proc. Eastern Joint Computer Con-erence,* 1960, 211-232. This paper describes how at the General Electric Company's Computer Department, a computer (IBM 04) is used in the design of digital computers. The functions erformed by programs for the following purposes are discussed: rrangement of Boolean equations to describe the over-all com-puter logic; interpretation of Boolean equations to determine ogic gates and other circuits required and how they are to be nterconnected; assignment of circuits to plug-in circuit cards; eneration of information for interconnecting circuit cards; nd preparation of logic schematic diagrams. The use by the ogician of these programs as a design tool and the use of the utput documents are described. Finally, the effect that the use f these programs has on the human organisation that designs nd builds the computers is considered.

1817 **Method of selecting optimum structure of digital analogue computers.** A. V. Shileiko, *Automatika i Telemekhanika,* **22,** No. 1, 1961, 89-96. (In Russian) English summary: 'A method of selecting the digital computer optimum structure is presented. The method is based on evolving the figure of merit. The structures compared are described by a set of quantities called "structure parameters." The problem is to find some assembly of structure parameters giving the extremal value for the figure of merit. An example of a digital analogue computer optimum structure is discussed.' 5 refs.

1818 **Parallel computing with vertical data.** W. Shooman, *Proc. Eastern Joint Computer Conference,* 1960, 111-115. This paper is concerned with digital computer organisation using a novel technique called Vertical Data Processing (VDP). In this technique multiple data are processed simultaneously one bit at a time using Boolean operations. Data organisation for VDP is described and a VDP machine is defined as a machine having the hardware to perform computations directly by addressing the data orthogonally. It is shown that the time taken to perform VDP operations is *not* a function of the number of numbers being processed. A general description is given of a hypothetical machine, called the Orthogonal Computer, which, in order to overcome certain limitations in VDP, employs both VDP and conventional (or Horizontal Data Processing) techniques. The application is discussed of VDP to specific problems: certain payroll deductions; finding the rank of a number in a sequence of numbers; translation of mnemonic operation codes to their machine language representation.

1819 **Use of a digital/analog arithmetic unit within a digital computer.** D. Wortzman, *Proc. Eastern Joint Computer Conference,* 1960, 269-282. An account is given of how digital and analogue techniques might be used in an arithmetic unit of a digital computer. Such a unit employs parallel-serial interconnections of digital-to-analogue converters. The interconnections are under stored program control and are effected by selecting multiplexers which route the analogue signals to perform various arithmetic operations. The final analogue signal, which is the result of the computation, is converted to digital form by an analogue-to-digital converter. High speed is attained because of the extreme parallel nature of digital/analogue arithmetic, but using present techniques the analogue nature of the computation limits the accuracy to 4 or 5 significant decimal figures. 6 refs.

1820 **The use of index calculus and Mersenne primes for the design of a high-speed digital multiplier.** A. S. Fraenkel, *J. Assn. Computing Mchy.,* **8,** Jan. 1961, 87-96. The text of this paper is the same as that of the report 'Computer design using index arithmetic', *PB 149138,* (*C.A.,* **5,** August 1961, Ref. 1613).

1821 **Di-pulse logic.** K. E. Perry, M.I.T., *AD-255344,* 25 June 1959, 4 p., $1.60.

1822 **Flow-gating.** H. Guckel, T. Kunihiro and R. K. Crow, University of Illinois, *AD-256890,* 24 March 1961, 1 v., $8.60. This report concerns transistor selection and evaluation, the basic design problem, and the evaluation of the flow-gating memory. The proposed system consists of 14 flow-gating flip-flops, which constitute a 1/4 word (3 transistors per bit), the read-in driver (18/14 transistors per bit), the read-out driver (10/14 transistors per bit), and termination equipment (2/11 transistors per bit). The system uses five transistors per bit of which 12/14 are GF45011, 40/77 are N-101 and the remaining parts are of the N-100 type. The terminal properties are given. The AC behaviour is discussed in considerable detail. The read-in speed, after tolerance correction, is less than 90 nsec.; the read-out speed is in the vicinity of 80 nsec., when referenced to the input of the respective drivers. This apparently satisfies the proposed requirement of 150 nsec. access times.

1823 **Methodology note: On the design and re-design of systems.** B. R. Wolin, System Development Corp., *AD-230585 (PB 154763),* Nov. 1959, 37 p., $3.60. This report discusses some characteristics of complex, man-computer information processing systems and an approach to the design and improvement of such systems.

1824 **Minimal synthesis of the wye-form two-output switching network.** S. R. Petrick, Air Force Cambridge Research Labs., *AD-255842,* Jan. 1961, 5 p., $1.10. The problem treated is the simultaneous minimisation of three Boolean functions, X, Y, and Z such that if F1 and F2 are any two given Boolean functions we have F1=XY and F2=XZ. In switching-circuit terminology the problem consists of synthesising a minimal Y-network to realise two arbitrary switching functions. By reducing the given two-output problem to an equivalent single-output problem, the required minimal synthesis procedure is found for the case where each of the functions X, Y and Z is restricted to be of the product-of-sums form.

1825 **A proposed system of redundancy to improve the reliability of digital computers.** W. H. Pierce, Stanford University, *AD-241645 (PB 150202),* 29 July 1960, 61 p., $6.60. The use of redundancy to improve reliability of digital systems is investigated for cases in which the redundancy is the simultaneous calculation of a digit by parallel devices. The purpose of the investigation is primarily to develop a system theory for the use of mass produced assemblies of microelectronics elements for digital computers. Binary systems which use a decision procedure of the optimum type, or near optimum systems of the same configuration but different weights, are analysed assuming statistical independence of errors. The use of decision elements, which carry out the decision in real time, is proposed on low levels of organisation, and error in these elements can be tolerated. A design procedure for using multiplexing is given. 7 refs.

1826 **Digital computer control unit.** Standard Telephones & Cables Ltd., *B.P. 872750,* 12 July 1961. This patent describes a control unit with simplified arrangement of index register and address calculator unit.

1827 **Program control system for digital computers.** Int. Business Machines Corp., *U.S.P. 2978175,* 4 April 1961. This patent is concerned with a digital computer having supplementary stores not directly involved in the computations. Such computer is provided with supplementary control means operating, when a given group of digits of an instruction word is in a predetermined permutation, to control the supplementary stores by a group of different digits of the same instruction word.

1828 **Multi-address data processing system.** Minneapolis-Honeywell Regulator Co., *U.S.P. 2978679,* 4 April 1961. This patent describes a multi-address data processing system in which each address position in a machine word can be read out at different times in a machine cycle from the same location in a recirculating shift register which stores the word.

1829 **Data transfer circuitry.** Int. Business Machines Corp., *U.S.P. 2979260,* 11 April 1961. This patent is concerned with improved arrangements for accomplishing the proper sequencing or transfer of digits during digital computer operations, particularly multiplication and division. The data transfer network takes the form of flexibly controlled pulse distribution chains whose function is to arrange and accelerate transfer of digits between registers and to reduce loss of time between successive transfers.

1830 **Magnetic core matrix driving circuitry.** Information Systems Inc., *U.S.P. 2979700,* 11 April 1961. Magnetic core circuitry for reading data into and/or out of a magnetic core matrix described.

See also :—
Techniques: Ref. 1910.
Elements: Ref. 1958.

LEARNING AND PATTERN RECOGNITION

1831 **Algorithmic unsolvability of problem of recognition of recursive event representability by finite automata.** M. A. Aizerman, L. A. Gusev, L. I. Rozonoer, I. M. Smirnova and A. A. Tal, *Automatika i Telemekhanika,* **22,** No. 6, 1961, 748-755. (In Russian) English summary: 'An idea of recursive event formalising the "event effectively given by a word description" is introduced. The problem of recognition of recursive events which are representable in a finite automaton is suggested and the theorem of its algorithmic unsolvability is proved. At the same time, an idea of representation of a recursive function in a finite automaton is given and a recognisability criterion for representable recursive functions is given.' 8 refs.

1832 **Finite automata, pattern recognition and perceptrons.** H. B. Keller, *J. Assn. Computing Mchy.,* **8,** Jan. 1961, 1-20. The author suggests that the all too frequent emphasis on the anthropomorphic aspects of automata, with the subsequent morass of psychological and physiological terminology introduced, conceals the nature of the basic (mathematical) problem that must be considered. The first part of this paper presents a formulation of the general problem posed by many automata, namely, to find a specific set function or class of set functions. The problem of 'recognising' geometric patterns by automata is then considered and a specific device that solves such problems with some generality is described. The next part of the paper is concerned with a more or less specifically defined device called a perceptron. An attempt is made to define a perceptron-like automaton as a nerve-net. It is shown that such a device can be represented at any instant of time as a very special type of set function. Some questions regarding the possibility of solving the basic discrimination problem with these special set functions, are then considered. A concept is introduced that should prove useful in treating approximate discrimination problems. 5 refs.

1833 **A method of voice communication with a digital computer.** S. R. Petrick and H. M. Willett, *Proc. Eastern Joint Computer Conference,* 1960, 11-24. This paper presents a pattern recognition procedure for achieving automatic identification of spoken words which has been developed and instrumented using an 18 channel vocoder and the Cambridge Computer of the U.S. Air Force Cambridge Research Laboratories. The process depends upon the representation of a spoken word by a sequence of octal digits which describe the amount of instantaneous power in each of 18 frequency bands at time intervals of 1/50 second. Essentially, recognition is achieved by matching such a digital representation of a spoken word against a set of stored word 'masks', one for each word to be recognised. To develop a set of masks, the speaker repeats a word several times and a mask is computed which optimises a certain recognition parameter. The printed word to be associated with the spoken word is then typed into the computer. For the speaker who prepared the masks almost 100 per cent recognition can be achieved. Various procedures dependent on the basic word recognition system are described, including an adaptive program which enables the computer to reorient itself automatically to a new speaker's voice. 14 refs.

1834 **Sets of tapes accepted by different types of automata.** S. Ginsburg, *J. Assn. Computing Mchy.,* **8,** Jan. 1961, 81-86. This paper presents a number of different types of one-way automata (i.e., automata that read tapes from left to right only) and then shows that the family of sets of tapes accepted by at least one automaton of a particular type is the same for all types. 3 refs.

1835 **Adaptive sampled-data systems.** B. Widrow, Stanford University, *AD-243265 (PB 150113),* 15 July 1960, 44 p., $4.60. An adaptive sampled-data system model that is quasi-statically linear and makes use of performance feedback for self-optimisation is evaluated. The goal of adaptation is to minimise a mean-square error. Analytical results derived from the model show that misadjustments are inversely proportional to adaptation rates. Adaptation taking place at different administrative levels within the same system may be treated analytically as separate phenomena because of the great disparities in the averaging times. Misadjustments developed at the various levels add. The adaptive model and the analytical results comprise a small-signal linear theory of adaptation. 13 refs.

1836 **An approach to pattern recognition using linear threshold devices.** R. L. Mattson, Lockheed Aircraft Corp., *AD-246244 (PB 154571),* Sept. 1960, 31 p., $3.60. The general problem of pattern recognition is represented as a mapping between three fundamental spaces. A pattern space, consisting of the patterns of interest; a data space, consisting of measurements made on the patterns; and a classification space, consisting of the various classes of patterns to be recognised. The mapping from pattern space to data space is accomplished by equipment which measures characteristics of the patterns of interest which have utility for the system. Three examples are presented to illustrate the way in which this initial processing might be accomplished. An automatic design procedure is presented for a binary classification system capable of mapping from the data space into a recognition class in the classification space. The binary classification system uses networks of linear threshold devices to perform this mapping. These networks are easily designed by a high-speed digital computer, and the time and storage requirements are small enough to make the procedure attractive for a wide variety of pattern recognition problems. The networks can be constructed by using magnetic core materials, or simulated by using a special-purpose digital computer. If the initial data processing of the patterns of interest isolates a set of characteristics which can be effectively used, the rest of the pattern recognition problem becomes fully automatic. 8 refs.

1837 **A magnetic integrator for the Perceptron Program.** J. K. Hawkins and C. J. Munsey, Aeronutronic, *AD-241392 (PB 150142),* 30 July 1960, 63 p., $6.60. The most significant result of the research programme described is the construction and successful operation of a learning machine, employing magnetic integrators as storage for experience data. The machine is capable of learning all possible linear-logic functions of up to four input variables, and some functions of five variables. The machine is constructed along the lines of the association-response portion of the Perceptron system, differing only in detail with respect to growth logic, logical levels, etc. Successful operation of the machine has demonstrated the practicability of constructing Perceptron-type systems using the magnetic integrator component developed. The configuration and important characteristics of the learning machine and the integrator components are summarised. 11 refs.

1838 **Principles of neurodynamics, perceptrons and the theory of brain mechanisms.** F. Rosenblatt, Cornell Aeronautical Lab., Inc., *AD-256582,* 15 March 1961, 622 p., $28.60. Part I attempts to review the background, basic sources of data, concepts, and methodology to be employed in the study of perceptrons. Parts II and III are devoted to a summary of the established theoretical results obtained to date. Part II deals with the theory of three-layer series-coupled perceptrons, on which most work has been done to date. Part III deals with the theory of multi-layer and cross-coupled perceptrons. Part IV is concerned with more speculative models and problems for future analysis. Of necessity, the final chapters become increasingly heuristic in character, as the theory of perceptrons is not yet complete, and new possibilities are continually coming to light. 116 refs.

1839 **Some principles of reorganization in self-organizing systems.** M. L. Babcock, A. Inselberg et al, University of Illinois, *AD-239721 (PB 149173),* 24 June 1960, 112 p., $9.60. Contents:— Property detector nets and fields: Interaction in a one-dimensional layer, Isotropic action functions, Anisotropic action functions, Counting networks; Connection possibilities and distinguishable stimulus patterns in cellular layers; Notes on the synthesis of property filters: Signal-pattern analogues, A redundancy-reducing transformation; Resolution and circuitry of non-sequential property filters; Property filtration in the organism: Biological support for synthetic devices, Property filters born, not built. 24 refs.

1840 **Character recognition system.** Bell Telephone Labs., Inc., *U.S.P. 2978675,* 4 April 1961. This patent relates to a system of statistical type for the recognition of characters or other line trace patterns. A pattern is scanned to detect portions occupying preselected portions of a matrix of areas, the detected pattern portions are systematically compared with corresponding areas of probability matrices for a set of characters and correlation signals are developed.

MATHEMATICS

1841 **On approximating transcendental numbers by continued fractions.** E. Karst, *Commun. ACM*, **4**, April 1961, 171. Brief note referring to previous notes on the evaluation and approximation of e^x appearing in *ibid*, **3**, Sept. 1960, 500 (*C.A.*, **4**, Nov. 1960, Ref. 2117) and Dec. 1960, 649 (*C.A.*, **5**, Feb. 1961, Ref. 1846). An example is given to show that each irrational and transcendental number can be expressed to any accuracy desired as an infinite continued fraction.

1842 **On the approximation of curves by line segments using dynamic programming.** R. Bellman, *Commun. ACM*, **4**, June 1961, 284. This note refers to the paper 'Approximation of curves by line segments', H. Stone, *Maths. of Computation*, **15**, Jan. 1961, 40-47 (*C.A.*, **5**, Feb. 1961, Ref. 247) and shows how dynamic programming can be applied to the problem of obtaining a best fit of broken line segments to a curve. 3 refs.

1843 **Bemerkung über eine Lösungsmethode der Differentialgleichungssysteme.** (Remarks on a method of solving systems of differential equations.) S. Fenyö, *Ordinary Differential Equations Proc.**, 1960, 399-402. (In German.)

1844 **Bessel functions of integral order and complex argument.** M. C. Gray, *Commun. ACM*, **4**, April 1961, 169. Brief note suggesting an extension to the complex argument of the Stegun-Abramowitz method for generating Bessel functions of real argument. 3 refs.

1845 **Sur certaines applications de l'intégration approchée.** (On certain applications of approximate integration.) F. Ceschino, *Ordinary Differential Equations Proc.**, 1960, 42-47. (In French) It is often found when establishing stable conditions in the approximate integration of differential equations representing motion, that it is impossible to increase the size of the integration step. This paper compares with regard to this problem the different formulae of Adams.

1846 **The condition of certain integral equations.** J. Todd, *Ordinary Differential Equations Proc.**, 1960, 306-311. This paper is concerned with the Lichtenstein-Gerschgorin integral equation and compares direct and iterative methods of solution in the case of mapping of an ellipse on to a circle. 10 refs.

1847 **Sur la délimitation du reste dans les formules d'approximation linéaires de l'analyse.** (On determining the bounds of the remainder in linear approximation formulae of numerical analysis.) T. Popoviciu, *Ordinary Differential Equations Proc.**, 1960, 441-446. (In French). In many approximation formulae, the remainder, or complementary term $R[f]$ is a linear function (additive and homogeneous) defined over a vectorial space S, formed by the functions $f=f(x)$, finite and continuous over an interval I of the real axis. It is important to be able to determine convenient bounds for the remainder. In this paper, some remarks are made on a more general representation of the remainder which shows its structure better. 15 refs.

1848 **Eigenvalues of a symmetric 3×3 matrix.** O. K. Smith, *Commun. ACM*, **4**, April 1961, 168. The development of an explicit solution for real, symmetric 3×3 matrices is briefly outlined.

1849 **Estimation d'erreurs dans la résolution de problèmes aux limites.** (Error estimation in the solution of boundary problems). C. Blanc, *Ordinary Differential Equations Proc.**, 1960, 480-485. (In French.)

1850 **On existence, uniqueness, and numerical evaluation of solutions of ordinary and hyperbolic differential equations.** J. B. Diaz, *Ordinary Differential Equations Proc.**, 1960, 581-602. This paper is concerned with the initial value problem: $\frac{dy}{dx}=f(x,y)$, $y(x_0)=y_0$, and the characteristic boundary value problem: $u_{xy}=f(x,y,u,u_x,u_y)$, $u(x_0,y)=\tau(y)$, $u(x,y_0)=\sigma(x)$, $\sigma(x_0)=\tau(y_0)$. After a preliminary survey of related results, a general uniqueness theorem for the ordinary differential equation $\frac{dy}{dx}=f(x,y)$ is developed. The general uniqueness theorem for the hyperbolic partial differential equation $u_{xy}=f(x,y,u)$ which is proved, is an exact analogue of the general uniqueness theorem for the ordinary differential equation $\frac{dy}{dx}=f(x,y)$. 23 refs.

1851 **Fonctions holomorphes (α) et leur approximation par polynômes aréolaires.** (Holomorph functions (α) and their approximation by aerolar polynomials). N. Teodorescu, *Ordinary Differential Equations Proc.**, 1960, 177-212. (In French.) 11 refs.

1852 **Fourier transforms and analytical functions.** N. Artémiadis, *Ordinary Differential Equations Proc.**, 1960, 380-383. This paper presents some results concerning the general problem: Given a function f of the class $L_1(-\infty,\infty)$, find an estimation of it if certain assumptions are made about its Fourier transform. 4 refs.

1853 **General report on the numerical treatment of integral and integro-differential equations.** A. Walther and B. Dejon, *Ordinary Differential Equations Proc.**, 1960, 645-671. This paper commences by listing 24 basic text books on integral and integro-differential equations and their numerical treatment, and gives 11 types of integral and integro-differential equations. The following numerical methods are then outlined: methods of finite differences and sums; minimisation of the residual-least squares method and collocation method; method of reduction; method of the degenerate kernel; method of moments; iterative methods; variational methods; Monte Carlo methods; analogue methods. 107 refs.

1854 **Sur l'intégration numérique des équations intégrales du type de Volterra.** (On the numerical integration of integral equations of Volterra type.) M. Laudet and H. Oulès, *Ordinary Differential Equations Proc.**, 1960, 117-121. (In French) This paper is concerned with the Volterra equation of the second kind

$$\int_{t_0}^{t} \varphi[t,\ \tau,\ y(\tau)]d\tau+y(t)=f(t)$$

where f and φ are known regular functions. The method of integration proposed by E. Aparo consists of calculating the values of y for t_0, t_0+h, . . . , t_0+nh, . . . The paper presents methods for calculating y_1 and y_n $(n\geqslant 2)$. 3 refs.

1855 **Sull'integrazione approssimata delle equazioni della meccanica non-lineare.** (On approximate integration of equations of non-linear mechanics.) D. Graffi, *Ordinary Differential Equations Proc.**, 1960, 447-457. (In Italian.)

1856 **An integrodifferential equation.** C. Pucci, *Ordinary Differential Equations Proc.**, 1960, 608-612, This paper discuses the solution of the integro-differential equation

$$u(x,y)=f(x,y)+\int_0^y k(y,\eta)\,\frac{\partial u(x,\eta)}{\partial x}\,d\eta,$$

where f and k are prescribed functions, f continuous in the half strip $A(0\leqslant x\leqslant 1,\ 0\leqslant y)$ and k continuous for $y\geqslant\eta\geqslant 0$.

1857 **An iterative method for solving nonlinear integral equations.** H. F. Bueckner, *Ordinary Differential Equations Proc.**, 1960, 613-643. This paper describes an iterative method which was developed for Nekrasov's integral equation

$$\theta(s)=\frac{\mu}{3}\int_0^{\pi} L_0(s,t)\,\frac{\sin\theta(t)}{1+\mu\int_0^t \sin\theta(\tau)d\tau}\,dt;\ 0\leqslant s\leqslant\pi$$

with the kernel

$$L_0(s,t)=\frac{2}{\pi}\sum_{n=1}^{\infty}\frac{1}{n}\sin ns\,.\,\sin nt=\frac{1}{2\pi}\log\frac{\sin^2\frac{s+t}{2}}{\sin^2\frac{s-t}{2}}$$

4 refs.

1858 **Iterative methods for the numerical solutions of ordinary differential equations.** M. Altman, *Ordinary Differential Equations Proc.**, 1960, 174-176. An iterative method, based on finding the zero of a nonlinear functional in a Banach space, is suggested for ordinary differential equations, and is stated to be applicable to integral and integro-differential equations as well.

1859 **Iterative solutions of boundary value problems using remainder terms of Taylor expansions.** R. Nicolovius, *Ordinary Differential Equations Proc.**, 1960, 162-173. After briefly discussing methods for the numerical solution of boundary value problems based on transformation into integral equations, a method is derived, and examples of its use given, for obtaining a convergent iterative procedure directly from a boundary value problem by using remainder terms of Taylor expansions. 3 refs.

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* For full title see Ref. 2103.

1860 **Mathematical programming and integral equations.** J. Douglas, *Ordinary Differential Equations Proc.**, 1960, 269-274. It is observed that the numerical solution of integral equations of the first kind by the replacement of the integral equation by a system of algebraic equations can lead to difficulties, mainly instability, both for Fredholm and Volterra equations. It is shown how this difficulty can be overcome with the aid of mathematical programming.

1861 **Méthode d'intégration numérique des équations intégrales intégro-différentielles du type de Volterra de seconde espèce. Formules de Runge-Kutta.** (Method for numerical integration of integral and integro-differential equations of Volterra type of the second kind. Runge-Kutta formulae.) P. Pouzet, *Ordinary Differential Equations Proc.**, 1960, 362-368. (In French) Runge-Kutta formulae are presented for Volterra integral and integro-differential equations of the second kind and numerical results are given for particular equations. 2 refs.

1862 **Su un metodo numerico per la risoluzione della equazione integrale di Volterra.** (On a numerical method for the solution of Volterra's integral equation.) R. Pennacchi, *Ordinary Differential Equations Proc.**, 1960, 330-350. (In Italian) This paper describes a method (programmed for the IBM 650 and IBM 1620) for the solution of Volterra's equation of the second kind:

$$\varphi(x) = f(x) + \int_{x_0}^{x} g[x, y, \varphi(x)]\,dy$$

See also Ref. 1863.

1863 **Applicazione sui calcolatori elettronici tipo 650 IBM e 1620 IBM.** (Applications on IBM 650 and IBM 1620 electronic computers). M. A. Sneider, *Ordinary Differential Equations Proc.**, 1960, 351-354. (In Italian) This paper outlines applications of the numerical method described in Ref. 1862. Brief specifications of the IBM 650 and IBM 1620 are given. Programming of the two equations:

$$\varphi(x) = 10^7(1 - \cos\frac{x}{100}) - 5.10^5 \int_0^x e^{-10^5 y} \sin\left(\frac{x-y}{100}\right)\varphi(y)dy$$

$$\varphi(x) = 1 + \int_0^x e^{-xy}\,\varphi^2(y)\,dy.$$

is indicated and error determination is discussed. Results for the two equations are tabulated.

1864 **Natürliche Eigenwertprobleme bei gewöhnlichen Differentialgleichungen.** (Natural eigenvalue problem for ordinary differential equations.) E. Bukovics, *Ordinary Differential Equations Proc.**, 1960, 355-361. (In German.) 4 refs.

1865 **Über ein neues Iterationsverfahren zur Lösung von Integral und Integrodifferentialgleichungen.** (On a new iterative method for the solution of integral and integro-differential equations.) T. Frey, *Ordinary Differential Equations Proc.**, 1960, 384-387. (In German.)

1866 **A new difference method for solution of certain second order non-linear differential equations.** A. S. Douglas and W. D. Ashton, *Ordinary Differential Equations Proc.**, 1960, 228-250. The approximate solution, by difference replacement methods, of the equation $d^2\Phi/dr^2 + f(r)\Phi^n = 0$, where boundary conditions are given for Φ at each end of a range of integration, is discussed. A method, suitable for use with a digital computer, is suggested which is suitable for all values of n provided $f(r)$ is a well-behaved function. For chosen functions $f(r)$ and given values of n, comparison is made between solutions obtained using the method and those derived analytically or by other numerical processes. It is shown that a good approximation can be obtained rapidly by use of the method.

1867 **On the numerical integration of ordinary differential equations and the determination of error bounds.** F. Krückeberg and H. Unger, *Ordinary Differential Equations Proc.**, 1960, 369-379. Methods of error estimation for procedures for numerical integration of ordinary differential equations are discussed. 9 refs.

1868 **The numerical solution of ordinary differential equations in Chebyshev series.** C. W. Clenshaw, *Ordinary Differential Equations Proc.**, 1960, 222-227. A numerical method is outlined which is designed to find a 'well-behaved' solution, over a finite range, of a linear differential equation with polynomial coefficients; 'well-behaved' means continuous, finite and having a finite number of maxima and minima. The application of the method is then described in two different fields: the computation of polynomial approximations to mathematical functions; and the evaluation of eigenvalues. 2 refs.

1869 **The numerical solution of a singular integral equation.** E. Isaacson and K. Grossman, *Ordinary Differential Equations Proc.**, 1960, 300-305. This paper describes experience in solving the singular integral equation

$$k(x, y) = \int_D \int \frac{(\xi - x)\Phi\xi + (\eta - y)\Phi\eta}{[(\xi-x)^2 + (\eta - y)^2]^{3/2}}\,d\xi\,d\eta$$

where the domain D is the lower unit semi-circle $\xi^2+\eta^2<1, \eta<0$; the region in which (x,y) varies is the same lower unit semi-circle. The function Φ is not uniquely determined by the above equation, but is specified by the following auxiliary boundary conditions

$$\Phi_\eta - \Phi = 0 \text{ on } \eta = 0$$
$$\Phi \sim \theta\,(\sqrt{1-\xi^2-\eta^2}) \text{ as } \xi^2+\eta^2 \longrightarrow 1.$$

5 refs.

1870 **Numerische Auflösung der Integralgleichung des Robinschen Problems für eine torusartige Berandung.** (Numerical solution of the integral equation of Robin's problems for a toroid). E. Martensen, *Ordinary Differential Equations Proc.**, 1960, 129-150. (In German.) 5 refs.

1871 **Perturbed boundary-value problems and their approximate solution.** O. Vejvoda, *Ordinary Differential Equations Proc.**, 1960, 37-41. In this paper it is shown how, by means of successive approximations, a solution (if it exists at all) can be found for the boundary-value problem:

$$\dot{x} = f(t,x) + \epsilon g(t,x,\epsilon)$$
$$u(x(a),x(b)) + \epsilon v(x(a),x(b),\epsilon) = 0.$$

2 refs.

1872 **The propagation of round-off error in the numerical solution of initial value problems involving ordinary differential equations of the second order.** P. Henrici, *Ordinary Differential Equations Proc.**, 1960, 275-291. Finite difference methods are considered for the direct numerical solution of the initial value problem $y'' = f(x,y)$, $y(a)$ and $y'(a)$ given (first derivative missing), without reduction to a system of first order equations. Results of statistical experiments on the IBM 709 show that there is considerable difference for rounded operations in the values y_n defined by the simple finite difference method $y_{n+1} - 2y_n + y_{n-1} = h^2 f_n$ and by its summed form. The paper discusses the answers to the questions: (1) Under what circumstances can an improvement in the round-off error be expected by summing the difference equations? (2) Can a quantitative prediction be made of mean and standard deviation of round-off error in a given problem, both with and without summing? 11 refs.

1873 **Sur quelque équations de type recurrentiel, et sur leurs applications numériques aux équations différentielles et intégro-différentielles.** (On some equations of recurrent type and their numerical application to differential and integro-differential equations). J. Delsarte, *Ordinary Differential Equations Proc.**, 1960, 104-116. (In French) This paper is concerned with a generalisation of the theory of mean-periodic functions of a real variable.

1874 **Rapport général sur le traitement numérique des équations différentielles.** (General report on the numerical treatment of differential equations.) F. Genuys, *Ordinary Differential Equations Proc.**, 1960, 89-103. (In French) A brief survey is given of methods for the numerical solution of differential equations. For initial value problems, difference methods, extrapolation methods, Runge Kutta methods and analytic methods are discussed. For boundary value problems, difference methods, Tir's method, analytic methods and the treatment of an initial value problem as a boundary value problem are discussed. 14 refs.

* For full title see Ref. 2103.

1875 **Recursive computation of certain integrals.** W. Gautschi, *J. Assn. Computing Mchy.*, **8,** Jan. 1961, 21-40. There are usually cases in which a particular computing method simply fails to work but, fortunately, suitable modifications are often at hand which may turn the method into one of general applicability. This paper presents an elementary example in illustration of the foregoing remark. The method in question simply consists of evaluating a finite sequence of real numbers by means of a linear first-order recurrence relation. Such calculations occur quite frequently, particularly in connection with the evaluation of definite integrals. Criteria for forward versus backward recurrence are derived and other related questions are discussed, such as the invariance of these criteria with respect to linear substitutions on the recurrence relation and the computation, or choice, of the initial value in the case of backward recursion. The results are applied to the recursive computation of

$$\beta_n(x) = \int_{-1}^{1} t^n e^{-xt}\,dt \quad \text{and of} \quad E_n(x) = \int_{1}^{\infty} t^{-n} e^{-xt}\,dt.$$

15 refs.

1876 **Solution of ordinary differential equations by trigonometric interpolation.** C. Lanczos, *Ordinary Differential Equations Proc.**, 1960, 22-32. This paper discusses the solution of ordinary differential equations using the global perturbation method which is based on the properties of the Fourier series and yields an explicit numerical scheme which can be utilised for an effective error estimation and, if necessary, an added correction to the solution obtained by the usual step-by-step extrapolation process. Interpolation occurs, not in sections with the help of local polynomials, but in a global way with the help of trigonometric interpolation so that the gradual accumulation of truncation errors is avoided. 4 refs.

1877 **Les solutions asymptotiques des équations différentielles et l'évaluation des restes.** (The asymptotic solutions of differential equations and the evaluation of remainders.) K. Bochenek, *Ordinary Differential Equations Proc.**, 1960, 433-440. (In French) This paper illustrates the application of asymptotic expansions to numerical computation, taking as an example the differential equation $y''+qy=0$, where the function q has for $x\longrightarrow\infty$ the asymptotic expansion

$$q \sim \sum_{n=0}^{\infty} q_n x^{-n},\ q_0 \neq 0.$$

1878 **Some estimates of spectra of matrices.** M. Fiedler, *Ordinary Differential Equations Proc.**, 1960, 33-36. The numerical solution of integral equations often involves solving systems of linear algebraic equations. The location of eigenvalues of the corresponding matrix (or other matrices) plays an important part in, for example, the determination of convergence of various numerical methods which may be used. This paper discusses some results concerning the location of the spectrum of a matrix.

1879 **Some numerical solutions of two-point eigenvalue equations with one boundary at infinity.** D. C. Gilles, *Ordinary Differential Equations Proc.**, 1960, 251-257. This paper gives a preliminary account of investigations into the determination of the solutions of the eigenvalue equation $y''+\{\lambda+F(x)\}\,y=G(x)$ where $G(x)=0$ or $G(x)=\int_0^x g(x,t)y(t)\mathrm{d}t$ with the boundary conditions $y(0)=0$, $y\longrightarrow 0$ as $x\longrightarrow\infty$. Conditions are imposed on $F(x)$ and $G(x)$ such that the equation remains finite when $x=0$ and $F(x)\longrightarrow 0$ as $x\longrightarrow\infty$. Three methods of solution are outlined and their effectiveness discussed; these are the forward integration method, the matrix method and Galerkin's method.

1880 **The stability of solutions of differential and integral equations.** G. J. Makinson and A. Young, *Ordinary Differential Equations Proc.**, 1960, 499-509. By means of three examples, this paper compares the stability and accuracy of differential and integral equation solutions. The examples are:

(1)
$$y(x) - \frac{2x}{\sqrt{\pi}} = 2\int_0^x (x-2t)y(t)\mathrm{d}t$$

and the corresponding differential equation

$$y'' + 2xy' = 0,\ y(0) = 0,\ y'(0) = \frac{2}{\sqrt{\pi}}$$

(2)
$$y' = 12y - 11e^x,\ y(0) = 1$$

which integrated gives the Volterra equation

$$y = 12 - 11e^x + 12\int_0^x y(t)\mathrm{d}t$$

(3)
$$y'' + \lambda y = 12x\,(x-1),\ y(0) = y(1) = 0$$

from which is obtained the Fredholm equation

$$y(x) = x^4 - 2x^3 + x + \lambda\int_0^1 k\,(x,t)y\,(t)\,\mathrm{d}t.$$

4 refs.

1881 **Theory of numerical convergence of iterative processes with applications to differential equations.** S. Moriguti, *Ordinary Differential Equations Proc.**, 1960, 423-432. The author has previously discussed the effect of rounding errors on the convergence of some particular iterative processes, including Newton's iteration for the k-th root, that for the inverse of the k-th root, and an iterative solution of a linear equation for one unknown. In the present paper, some results previously obtained are extended and applications to the numerical solution of differential equations suggested. 3 refs.

1882 **Extraction and extension of matrices in computer calculations.** W. H. Richardson, University of California, *AD-251824 (PB 154049),* June 1960, 7 p., $1.10. The problems involved are: the extraction of a submatrix from a matrix; and the extension of a matrix to a matrix of larger dimensions with the original matrix as a given submatrix of the larger and the rest of the larger matrix composed of zero submatrices.

1883 **On numerical integration of ordinary differential equations.** A. Nordsieck, University of Illinois, *AD-256363,* May 1961, 52 p., $5.60. A reliable, efficient, general purpose method for digital computer integration of systems of ordinary differential equations is described. The method operates with the current values of the higher derivatives of a polynomial approximating the solution. It is thoroughly stable under all circumstances, incorporates automatic starting and automatic choice and revision of elementary interval size, approximately minimises the amount of computation for a specified accuracy of solution, and applies to any system of differential equations with derivatives continuous or piecewise continuous with finite jumps.

1884 **The numerical solution of Fredholm integral equations of the first kind.** J. T. Jefferies and F. Q. Orrall, Air Force Cambridge Research Labs., *AD-250862 (PB 154890),* Nov. 1960, 13 p., $1.60. A method is proposed for finding smooth solutions of Fredholm's integral equation of the first kind. Examples of the method from the theory of radiative transfer are given. 2 refs.

See also:—
Techniques: Refs. 1891, 1895, 1900, 1902, 1904 and 1905.
Elements: Ref. 1939.
Applications, Electronics: Ref. 2033.

TECHNIQUES

1885 **Algorithms.** *Commun. ACM,* **4,** April 1961, 176-182. Consists of the following algorithms (in ALGOL 60), certifications (of successful use of previously published algorithms) and a remark:—

a. **Algorithm 41: Evaluation of a determinant.** J. G. Solomon, p. 176. This procedure evaluates a determinant by triangularisation.

b. **Algorithm 42: Invert.** T. C. Wood, p. 176. Inverts a square matrix by applying a series of elementary operations to the matrix to reduce it to the identity matrix; these operations applied to the identity matrix yield the inverse.

c. **Algorithm 43: Crout with pivoting II.** H. C. Thacher, p. 176-177. Improvement of 'Algorithm 16: Crout with pivoting', G. E. Forsythe, *ibid,* **3,** Sept. 1960, 507-508 *(C.A.,* **4,** Nov. 1960, Ref. 2119).

d. **Algorithm 44: Bessel functions computed recursively.** M. E. Wojcicki, p. 177-178. Bessel functions of the first and second kind, $J_P(X)$ and $Y_P(X)$, integral order P, are computed by recursion for values of X.

* For full title see Ref. 2103.

e. **Algorithm 45: Interest.** P. Z. Ingerman, p. 178. This procedure calculates the periodic payment necessary to retire a loan when the interest rate on the loan varies (possibly from period to period) as a function of the as-yet-unpaid principal. See also the author's note in *ibid*, **3,** Oct. 1960, 542-543 (*C.A.*, **5,** Jan. 1961, Ref. 163).

f. **Algorithm 46: Exponential of a complex number.** J. R. Herndon, p. 178.

g. **Algorithm 47: Associated Legendre functions of the first kind for real or imaginary arguments.** J. R. Herndon, p. 178-179. Computes any $P_n^m(x)$ or $P_n^m(ix)$ for n an integer less than 20 and m an integer no larger than n.

h. **Algorithm 48: Logarithm of a complex number.** J. R. Herndon, p. 179.

i. **Algorithm 49: Spherical Neumann function.** J. R. Herndon, p. 179. Computes the spherical Neumann function $(\pi/2x)^{\frac{1}{2}}N_{r+\frac{1}{2}}(x)$.

j. **Algorithm 50: Inverse of a finite segment of the Hilbert matrix.** J. R. Herndon, p. 179. Computes the elements of the inverse of an $n \times n$ finite segment of the Hilbert matrix.

k. **Algorithm 51: Adjust inverse of a matrix when an element is perturbed.** J. R. Herndon, p. 180. If the $n \times n$ matrix $A = M^{-1}$ and a change, d, is made in the i,j-th element of M, this procedure calculates the corrected matrix for M^{-1} by adjusting matrix A.

l. **Algorithm 52: A set of test matrices.** J. R. Herndon, p. 180. This procedure provides an $n \times n$ matrix whose inverse and eigenvalues are known.

m. **Algorithm 53: Nth roots of a complex number.** J. R. Herndon, p. 180.

n. **Algorithm 54: Gamma function for range 1 to 2.** J. R. Herndon, p. 180. Computes $\Gamma(x)$ for $1 \leq x \leq 2$.

o. **Algorithm 55: Complete elliptic integral of the first kind.** J. R. Herndon, p. 180.

p. **Algorithm 56: Complete elliptic integral of the second kind.** J. R. Herndon, p. 180-181.

q. **Algorithm 57: Ber or bei function.** J. R. Herndon, p. 181. This procedure computes ber(z) if r is set equal to zero; bei(z) is produced if r equals 1.0.

r. **Remark: On frequently occurring errors in ALGOL-60 programs.** W. Borsch-Supan, p. 181. Some features in the syntax of ALGOL 60 which are often neglected by people writing algorithms are mentioned.

s. **Certification of Algorithm 3: Solution of polynomial equation by Bairstow-Hitchcock.** J. R. Herndon, p. 181. Brief note relating to the transliteration into BALGOL and testing on Burroughs 220 of the algorithm published in *ibid*, **3,** Feb. 1960, 74-75 (*C.A.*, **4,** June 1960, Ref. 822).

t. **Certification of Algorithm 10: Chebyschev polynomial $T_n(x)$.** J. R. Herndon, p. 181. Brief note relating to the transliteration into BALGOL and testing on Burroughs 220 of the algorithm published in *ibid*, **3,** June 1960, 353-354 (*C.A.*, **4,** Aug. 1960, Ref. 1441).

u. **Certification of Algorithm 13: Legendre polynomial $P_n(x)$.** J. R. Herndon, p. 181. Brief note relating to the transliteration into BALGOL and testing on Burroughs 220 of the algorithm published in *ibid*, **3,** June 1960, 353-354 (*C.A.*, **4,** Aug. 1960, Ref. 1441).

v. **Certification of Algorithm 20: Real exponential integral.** W. J. Alexander and H. C. Thacher, p. 182. Results obtained on the LGP-30 with the algorithm published in *ibid*, **3,** Oct. 1960, 540 (*C.A.*, **5,** Jan. 1961, Ref. 62).

w. **Certification of Algorithm 43: Crout II.** H. C. Thacher, p. 182. Results obtained on the LGP-30 with the algorithm referred to in *c* above.

1886 **Algorithms.** *Commun. ACM*, **4,** May 1961, 236-238. Consists of the following algorithms (in ALGOL 60) and certifications (of successful use of previously published algorithms):—

a. **Algorithm 58: Matrix inversion.** D. Cohen, p. 236. Matrix inversion by Gauss-Jordan elimination.

b. **Algorithm 59: Zeros of a real polynomial by resultant procedure.** E. H. Bareiss and M. A. Fisherkeller, p. 236-237. Algorithm for the method described in 'Resultant procedure and the mechanization of the Graeffe process', E. H. Bareiss, *J. Assn. Computing Mchy.*, **7,** Oct. 1960, 346-386 (*C.A.*, **4,** Dec. 1960, Ref. 2376).

c. **Certification of Algorithm 23: Mathsort.** R. W. Ranshaw, p. 238. Use on IBM 7070 of a modified form of the procedure published in *ibid*, **3,** Nov. 1960, 601 (*C.A.*, **5,** Feb. 1961, Ref. 257).

d. **Certification of Algorithm 30: Numerical solution of the polynomial equation.** W. J. Alexander, p. 238. Details of corrections found necessary on coding for the LGP-30 the algorithm published in *ibid*, **3,** Dec. 1960, 643 (*C.A.*, **5,** Feb. 1961, Ref. 258).

1887 **Algorithms.** *Commun. ACM*, **4,** June 1961, 255. Consists of the following algorithm (in ALGOL 60):— **Algorithm 60: Romberg integration.** F. L. Bauer. Integral of a function is calculated by the algorithm of Romberg.

1888 **Analogue solution of algebraic and transcendental equations by gradient method.** M. V. Rybashov, *Automatika i Telemekhanika*, **22,** No. 1, 1961, 77-88. (In Russian) English summary: 'The method for solving systems of finite equations on electronic analogue computers is described. There is formed via the initial system of finite equations on auxiliary system of differential equations with the property of having the system stable points of repose corresponding to the roots of the initial system. In the paper the peculiarities of this method are investigated and the conditions for this method to be most effective are determined.' 4 refs.

1889 **Analysis of internal computer sorting.** I. Flores, *J. Assn. Computing Mchy.*, **8,** Jan. 1961, 41-80. The first part of this paper provides descriptions and flow charts of the following methods for sorting information within a computer using its internal memory: straight insertion; centered insertion; binary insertion; sorting by counting; sorting by exchanging; digital sorting; linear selection; linear selection with exchanging; quadratic selection; quadratic selection preceded by group sorting (by linear selection with exchanging); two-way merge; three-way merge; *n*-way merge using *n*-way comparison box; *n*-way merge using conventional computer instructions; sorting by address calculation. In the second part of the paper, formulae are derived for the times taken by these methods. Finally, the methods for internal sorting are evaluated in terms of the reasons for sorting and the characteristics of the computer being used.

1890 **An answer to Mr. J. A. Lively's remarks on the paper "Amphisbaenic sorting".** H. Nagler, *J. Assn. Computing Mchy.*, **8,** Jan. 1961, 117. Letter replying to the letter by J. A. Lively, *ibid*, **7,** April 1960, 187 (*C.A.*, **4,** Aug. 1960, Ref. 1449) which commented on Nagler's paper 'Amphisbaenic sorting', *ibid*, **6,** Oct. 1959, 459-468 (*C.B.*, **3,** Oct. 1959, Ref. 2406). See also Ref. 1897.

1891 **On a class of iteration formulas and some historical notes.** J. F. Traub, *Commun. ACM*, **4,** June 1961, 276-278. This paper is concerned with the class of iteration formulae obtainable by rational approximations of Euler's formula. Brief historical notes on iterative procedures are followed by a derivation of Euler's formula with the associated error estimate in a new notation which simplifies the error estimate and suggests generalisations. The Padé approximants to the Euler polynomial are then considered and it is shown how a number of known formulae may be derived from this unified approach. There is a short discussion of the 'best' formula. 29 refs.

1892 **"Direct search" solution of numerical and statistical problems.** R. Hooke and T. A. Jeeves, *J. Assn. Computing Mchy.*, **8,** April 1961, 212-229. This paper is concerned with the solution of numerical problems for which classical methods of solution are unsuitable, by searching for an answer on a computer. The searching procedure described in this paper is called 'direct search' by which is meant sequential examination of trial solutions involving comparison of each trial solution with the 'best' obtained up to that time together with a strategy for determining (as a function of earlier results) what the next trial solution will be. After a simple description of direct search, it is explained heuristically. An account is given of a specific kind of strategy—pattern search. Examples are described in which direct search has been used in curve fitting problems, solving integral equations, maximising or minimising functions with or without restrictions on the independent variables, and solving systems of equations. 1 ref.

1893 **Division and square root in the quater-imaginary number system.** M. Nadler, *Commun. ACM*, **4,** April 1961, 192-193. This paper describes methods for performing division and the extraction of square roots in the quater-imaginary number system (which uses the imaginary number 2i as its base) presented in 'An imaginary number system', D. E. Knuth, *ibid*, **3,** April 1960, 245-247 (*C.A.*, **4,** July 1960, Ref. 1095). 4 refs.

1894 **An indirect chaining method for addressing on secondary keys.** L. R. Johnson, *Commun. ACM*, **4**, May 1961, 218-222. Methods for entering random-access files on the basis of one key are briefly surveyed. The widely used chaining method, based on a pseudo-random key transformation, is considered in more detail. An indirect chaining method is then presented which is essentially a generalisation of the chaining method in which all items are treated as overflows, and as such are independent of physical locations. The indirect chaining method is particularly applicable to a secondary key, and can be repeated on any desired number of keys. 7 refs.

1895 **A machine method for solving polynomial equations.** D. H. Lehmer, *J. Assn. Computing Mchy.*, **8**, April 1961, 151-162. This paper presents a method, particularly suitable for computers, for solving polynomial equations by searching the complex plane for roots. The method is intended as a subroutine by means of which the computer can solve polynomials that have arisen internally in the course of its own work on a larger problem, all without external supervision. The method is based on an algorithm for answering as cheaply as possible the 'basic question': Does a given polynomial have a root inside a given circle? Armed with this algorithm a search procedure is instituted which in $O(\log N)$ steps locates one or more roots of the given polynomial f inside a circle of radius $1/N$. More precisely, assuming that $f(0) \neq 0$ and starting with the unit circle, basic questions are asked doubling (or halving) the radius at each step. Soon there is found an annulus $R<|z|<2R$ where R is a power of 2, containing a root of f while the inner circle is free of roots. This annulus can be completely covered by 8 overlapping circles each of radius $5R/6$ with centres at $(5R/3)\exp(2\pi ik/8)$ $(k=0(1)7)$. The basic question is asked of these circles in turn to find one containing a root of f. The procedure of finding an annulus and covering it with 8 circles is repeated for the circle thus found, and so on until after completion of step K a circle of radius not exceeding $2(5/12)^K$ contains a root. (27 steps give a circle of radius less than $R.10^{-10}$). 4 refs.

1896 **A method for evaluating the area of the normal function.** F. B. Baker, *Commun. ACM*, **4**, May 1961, 224-225. Many statistical procedures require the cumulative area and ordinate of the normal function corresponding to a given deviate. The development of a program for the application of probit analysis to bio-assay led to the method described in this paper. 4 refs.

1897 **More on "Amphisbaenic sorting".** J. G. Mackinney, *J. Assn. Computing Mchy.*, **8**, Jan. 1961, 118. Letter also replying to Lively's remarks on Nagler's paper (see Ref. 1890).

1898 **Negative binomial probability distribution tables.** M. Hershkowitz, *Commun. ACM*, **4**, June 1961, 252. Letter briefly describing a FORTRAN program for computing negative binomial probability distribution tables, and giving an address from which copies of the program can be obtained.

1899 **Notes on a new pseudo-random number generator.** M. Greenberger, *J. Assn. Computing Mchy.*, **8**, April 1961, 163-167. Discusses the selection of parameter values for the mixed congruential variation of the multiplicative congruential method for generating pseudo-random numbers described in 'A new pseudo-random number generator', A. Rotenberg, *ibid*, **7**, Jan. 1960, 75-77 (*C.A.*, **4**, April/May 1960, Ref. 605). 10 refs.

1900 **Numerical integration of ordinary differential equations by difference methods with automatic determination of steplength.** K. Hain and F. Hertweck, *Ordinary Differential Equations Proc.**, 1960, 122-128. This paper describes a scheme for the integration of systems of first and second order differential equations and the complete flow diagram of the program is presented. Adams interpolation and extrapolation is used. The truncation error at each step is determined by the difference between the interpolated and extrapolated values and the steplength is automatically doubled or halved accordingly.

1901 **Polyphase merge sorting—an advanced technique.** R. L. Gilstad, *Proc. Eastern Joint Computer Conference*, 1960, 143-148. This paper is concerned with merge sorting techniques designed to make effective use of the tape drives used by a sort routine. A description is given of cascade merge sorting for the Honeywell 800, followed by a description of a further development—polyphase merge sorting. Finally, these two techniques are compared with normal two-way merge sorting.

1902 **A practical technique for the determination of the optimum relaxation factor of the successive over-relaxation method.** H. E. Kulsrud, *Commun. ACM*, **4**, April 1961, 184-187. The main difficulty in the use of the successive over-relaxation method for iterative solution of the difference analogue of an elliptic partial differential equation is the problem of obtaining a good estimate of the optimum relaxation factor. This paper describes a procedure for determining the optimum relaxation factor and presents some experimental results. 5 refs.

1903 **Programmed error correction on a decimal computer.** G. M. Weinberg, *Commun. ACM*, **4**, April 1961, 174-175. This paper refers to a previous paper by the author and B. Dimsdale in *ibid*, **3**, Dec. 1960, 649-652 (*C.A.*, **5**, Feb. 1961, Ref. 270), which reported the use of programmed Hamming codes for error correction on an IBM 7090. In the present paper, a modification is described of Hamming's technique to adapt it to decimal machines.

1904 **Some numerical experiments using Newton's method for nonlinear parabolic and elliptic boundary-value problems.** R. Bellman, M. L. Juncosa and R. Kalaba, *Commun. ACM*, **4**, April 1961, 187-191. This paper describes the numerical solution (on JOHNNIAC) using a generalisation of Newton's method, of a nonlinear parabolic equation of the form $u_t - u_{xx} = g(u)$ and of a nonlinear elliptic equation $u_{xx} + u_{yy} = e^u$. The results are compared with those using the Picard iteration procedure and it is shown that in many cases the Newtonian method offers substantial advantages in both time and accuracy. 12 refs.

1905 **Successive approximations and computer storage problems in ordinary differential equations.** R. Bellman, *Commun. ACM*, **4**, May 1961, 222-223. This paper refers to the solution of nonlinear differential equations with two-point boundary values by means of the technique of quasi-linearisation. This involves the use of a method of successive aproximations and it is shown how the method may be used without paying undue storage penalties. 2 refs.

1906 **Table look-at techniques.** P. M. Sherman, *Commun. ACM*, **4**, April 1961, 172-173, 175. Data processing and symbol manipulation often involve the 'mapping' of one set of integers into a second set. A technique, called 'table look-at', for performing this transformation is described which is generally applicable to any computer having index registers or the equivalent. After a general description, some short routines written in symbolic language (FAP) for the IBM 7090 are presented. The important characteristic of table look-at which distinguishes it from table look-up is that one and only one reference is made to a table. 1 ref.

1907 **TABSOL—a fundamental concept for systems-oriented languages.** T. F. Kavanagh, *Proc. Eastern Joint Computer Conference*, 1960, 117-136. Lack of efficient methods for thinking-through and recording the logic of complex information systems has been a major obstacle to the effective use of computers in manufacturing. This paper introduces 'decision structure tables', the essential element in TABSOL, a tabular systems-oriented language developed at General Electric Company. Decision structure tables can be used to describe complicated, multivariable, multi-result decision systems. Various approaches to the digital computer solution of structure tables are considered and it is stated that TABSOL will be contained in GECOM, General Electric's new general compiler to be implemented on the GE 225. Some benefits which have been observed in applying this language concept are discussed.

1908 **Tabular form in decision logic.** B. Grad, *Datamation*, **7**, July 1961, 22-26. This article explains, with the aid of simple examples, the use of tabular form in decision logic, and discusses the advantages of decision tables in systems analysis and computer programming. 2 refs.

1909 **Techniques: Editor's note.** R. W. Bemer, *Commun. ACM*, **4**, April 1961, 166. Some formulae are given for calculating $\sin n\theta$ and $\cos n\theta$ which are of assistance in planning subroutines. It is also suggested that θ should be computed by multiplying $n\theta$ by $1/n$, and binary reciprocals of some small decimal integers are given.

* For full title see Ref. 2103.

1910 **Theory of files.** L. Lombardi, *Proc. Eastern Joint Computer Conference,* 1960, 137-141. This paper is concerned with the theory of files, a tool for the logico-mathematical treatment of non-numerical data processing problems, such as machine accounting, information retrieval and mechanical translation. The main result obtained so far from the application of the theory of files is the formulation of a simple pattern to which the data flow of any information processing procedure conforms, regardless of how many files are involved. The flow of each file can be controlled and coordinated with the flow of the other files by means of five Boolean parameters, called 'indicators'. A description is given of a specially designed Algebraic Business Language which exploits this result for the purpose of programming data processing systems. The paper also discusses the impact of the theory of files on the logical design of data processors. 7 refs.

1911 **Topological ordering of a list of randomly-numbered elements of a network.** D. J. Lasser, *Commun. ACM,* **4,** April 1961, 167-168. This paper is concerned with a topological ordering problem, which could arise in any situation requiring the reduction of a network to a list, encountered in the analysis of PERT (Project Evaluation Review Technique) networks. A network of directed line segments free of circular elements is assumed. The lines are identified by their terminal nodes and the nodes are assumed to be numbered by a non-topological system. A simple technique for the IBM 7090 is presented which, given a list of the lines in numerical order, can be used to create at high speed a list in topological order. 1 ref.

1912 **Two-dimensional parity checking.** P. Calingaert, *J. Assn. Computing Mchy.,* **8,** April 1961, 186-200. Two-dimensional arrays of digital information occur in computer systems; the two dimensions may be physical, as on a magnetic tape or in a magnetic core matrix, or they may be conceptual, as in a numerical matrix. For purposes of error detection and correction, redundancy can be incorporated into an array of binary digits, or logical matrix, by the imposition of certain constraints upon specified groups of digits in the array. A common constraint is the specification of the parity sum of the digits in the group. It is natural to require that each parity check group lie wholly within a given row or column. Lower redundancy can be achieved by selection of parity check groups both from columns and from rows than from either alone. Such two-dimensional parity checking is discussed in this paper. 9 refs.

1913 **Computation in the presence of noise.** L. Bluestein, Columbia University, *AD-256737,* 1 April 1961, 25 p., $2.60. Two approximate methods are presented for analysing the effect of noise on computer solutions of differential equations. The computer's operation is assumed to be governed by a difference equation; the input message is assumed to be an additive mixture of a random signal and the undesired noise. It is shown that a bound may be placed on the effect of this additive noise and, because this bound satisfies a linear time-invariant difference equation, the stochastic properties of this bound are easily found. The alternative method considers the noise as a small random perturbation of the signal. A linear, time-varying difference equation with random parameters describing the effect of the noise is then obtained. It is shown that both techniques require less computational labour and information about the random properties of the signal and noise than do conventional methods.

1914 **An ORDVAC program for the transformation of geodetic ellipsoidal coordinates into Cartesian coordinates and vice versa.** A. R. Wooten, Ballistic Res. Labs., Aberdeen Proving Ground, *AD-255434,* Feb. 1961, 59 p., $5.60. The transformation of geodetic ellipsoidal coordinates into Cartesian coordinates and vice versa is programmed for the ORDVAC using a pseudo code—the One Address Floating Binary Double Precision Code.

1915 **Problems solved on high-speed computing equipment of the Applied Mathematics Laboratory, Supplement II, 1958-1959.** H. Smith and L. Chatfield, David Taylor Model Basin, *AD-250472 (PB 154355),* Jan. 1961, 28 p., $2.60. Brief descriptions of new problems programmed for solution on computers are presented. These problems fall into two general categories: naval engineering and management data analysis.

1916 **A sorting problem.** R. C. Bose and R. J. Nelson, Case Inst. of Tech., *AD-256333,* April 1961, 22 p., $2.60. A low upper bound is established for the number of comparisons required to sort n objects under the condition that the number of permutations be no larger than the number of comparisons.

1917 **Analogue computer set-up.** Boeing Airplane Co., *U.S.P. 2980330,* 18 April 1961. An analogue computer set-up is described for quickly and accurately determining the values of unknown quantities which satisfy a predetermined criterion function of such unknowns when such criterion function is either maximised or minimised, without violating predetermined constraint functions of the unknowns. A typical problem for which the set-up is suitable, is the determination of quantities of ingredients of an animal foodstuff to minimise cost.

See also:—
Mathematics: Refs. 1841, 1844, 1848, 1862, 1863, 1872, 1876 and 1879.
Analogue: Ref. 1985.
Applications, Physics: Ref. 2075.
Applications, Simulation: Ref. 2085*g*.

ACCESSORIES

1918 **Channeled magnetic head.** P. Magura, *IBM Technical Disclosure Bull.,* **4,** July 1961, 33. Extensive use of a magnetic head with tape causes the edges of the tape to wear small ledges in the surface of the head. Since the width of tape varies slightly, the tape rides up on the ledges causing the loss of information recorded in the outermost tracks. This is avoided by cutting grooves in the head surface adjacent to the outside tracks.

1919 **Code translator.** M.-Y. Hsiao, *IBM Technical Disclosure Bull.,* **4,** July 1961, 36-37. Description of a circuit for translating 6-bit codes into 4-out-of-8 codes.

1920 **Design of an improved transmission/data processing code.** R. W. Bemer, H. J. Smith and F. A. Williams, *Commun. ACM,* **4,** May 1961, 212-217, 225. This paper gives an informal description of a tentative standard character code which has been proposed to the American Standards Association X3.2 Subcommittee on Character Sets and Input/Output Media.

1921 **Distortion error detector.** H. R. Oeters, *IBM Technical Disclosure Bull.,* **4,** July 1961, 38. Description of a circuit which determines if the duration of a signal pulse on a data line is within or without the tolerance limits for a single, double or larger number of integral pulse lengths.

1922 **Further survey of punched card codes.** H. McG. Ross, *Commun. ACM,* **4,** April 1961, 182-183. Reference is made to 'Survey of punched card codes', H. J. Smith and F. A. Williams, *ibid,* **3,** Dec. 1960, 638, 642 (*C.A.,* **5,** Feb. 1961, Ref. 288) and a similar chart is provided for nine European punched card codes.

1923 **High-speed data transmission systems.** R. G. Matteson, *Proc. Eastern Joint Computer Conference,* 1960, 97-109. Areas of application for the transmission of digital computer data at high speed over standard telephone facilities are discussed. Equipment requirements for input/output, buffer converter, modulator/demodulator and transmission path are examined and equipment which has been developed by Stromberg-Carlson Division of General Dynamics Corporation is described as examples of these components. 4 refs.

1924 **High speed printer and plotter.** F. T. Innes, *Proc. Eastern Joint Computer Conference,* 1960, 153-160. An account is given of the Model 1063 High Speed Printer and Plotter, a magnetic tape fed device for high speed plotting of up to 6,000 points per second in ten simultaneous plots. At the same time it prints annotations for grid lines and draws the grid lines, all with the output paper moving at 10 inches per second. The machine may also be used simply as a high speed printer operating at a rate of 4,000 lines per minute with 100 characters per line.

1925 **Hot-Wire Anemometer Paper Tape Reader.** J. H. Jory, *Proc. Eastern Joint Computer Conference,* 1960, 267-268. An account is given of the Hot-Wire Anemometer Paper Tape Reader which operates by allowing air under pressure to pass through perforations in punched paper tape and be directed over electrically heated wire elements which are thereby cooled, causing their resistance to change and thus indicating the presence of a perforation in the tape.

1926 **Man-machine communication via simplified English.** E. M. Bennett, R. P. Mayer and P. R. Bagley, *Commun. ACM,* **4,** May 1961, 235-236. Brief accounts of projects at the Mitre Corporation concerned with the use of Basic English for computer input and output. 1 ref.

1927 **Optical read-only memory.** M. D. Fleisher and C. A. Burton, *IBM Technical Disclosure Bull.*, **4,** July 1961, 62-63. Description of an optical read-only memory system having a capacity of about 10,000 records in the form of individual strips carried on a drum. Each strip is approximately 0.005 inches thick, is made of a transparent material and is coated on one longitudinal edge with an opaque layer. Data is recorded in a binary code arrangement by notching this edge to remove the layer.

1928 **The printed motor: a new approach to intermittent and continuous motion devices in data processing equipment.** R. P. Burr, *Proc. Eastern Joint Computer Conference,* 1960, 325-342. An account is given of the printed dc motor which is characterised by high pulse torque capability and freedom from cogging or preferred armature positions. These attributes lead to a variety of applications in data processing equipment ranging from reel and capstan drives in magnetic and paper tape transports to detenting and positioning mechanisms. A typical example of an application in a paper tape transport is described. 1 ref.

1929 **UNIVAC-RANDEX II random access data storage system.** G. J. Axel, *Proc. Eastern Joint Computer Conference,* 1960, 189-203. This paper describes RANDEX II, a random access drum file capable of being used with any one of a number of UNIVAC systems. It has 198.6 million bits total storage capacity, and average data access time of 385 milliseconds. Two flying-magnetic-heads transfer data to and from the drum file unit. They are self-supported, by a hydrodynamically generated air film, over two magnetically plated drums. Detailed descriptions are given of the logic of operation and the overall drum file, construction of the flying heads, and the servo and mechanical adder which position the flying heads over selected addresses. 1 ref.

1930 **Computer Acquisition System, Model 1591.** Miglo Electronic Corp., *AD-256375,* March 1961, 12 p., $1.60. The Model 1591 Computer Acquisition System (CASY) accepts data in the form of three parallel words from either a Remington Rand 1103A or IBM 7090. Upon completion of the data acquisition, the data is transmitted in serial form over telephone voice lines in a format compatible with a MEC Model 1522-R Data Receiver. CASY is capable, with manual programming, of various modes of operation with either computer. Internally generated test inputs along with visual indicators allow self-checking of the system with a minimum of effort and external equipment.

1931 **A digital recording system for satellite tracking data.** T. P. Sifferlen and E. M. Hocking, NASA, *AD-256770,* May 1961, 23 p., $0.75. A digital recording system was designed and built for recording satellite tracking data, as received by the Minitrack System, on five-level punched paper tape at a rate of 100 characters per second. The tape from the digital recording system provides satellite direction cosine information, time, and date. The punch code is identical with that used in teletypewriter communication and is used to transmit the data via NASA communications circuits to the IBM 7090 computer for determining orbital elements.

1932 **Remote display console for computer processed data.** H. E. Zieman and D. I. Underwood, M.I.T., *AD-255086,* 13 Jan. 1961, 46 p., $4.60. The remote display console simulates an FSQ-7 situation display but can be located remotely from the processing computer with only a telephone-line or radio-link connection. The system has a 1300-cps, 92-bit message format which permits the transmission of approximately 14 messages/sec. A ferrite core memory stores 62 of these messages, each of which can consist of 4, 8 or 13 symbols. The console is completely self-contained except for the digital data receiver, which would normally be supplied by the telephone company. At 50 frames/sec the display is essentially flicker free and bright enough to be viewed comfortably in a well-lighted room. The tube used provides a resolution equivalent to 5000 to 8000 TV lines and presents negligible distortion of symbols to the extreme edges of the 19-in. tube.

1933 **Tape unit control system.** Nat. Cash Register Co., *U.S.P. 2978685,* 4 April 1961. This patent describes arrangements for the transfer of data between the internal memory of a digital computer and a number of magnetic tape units.

1934 **Analogue-to-digital converter.** Gen. Dynamics Corp., *U.S.P. 2979708,* 11 April 1961. An analogue-to-digital converter includes a free-running multivibrator which supplies pulses to a storage capacitor and to a counter.

1935 **Notation converter.** Gen. Dynamics Corp., *U.S.P. 2979709,* 11 April 1961. This patent describes circuitry for converting serial binary-coded decimal signals to a decimal pulse train in real time.

1936 **Notation converter.** Minneapolis-Honeywell Regulator Co., *U.S.P. 2981471,* 25 April 1961. Circuitry is described for converting data from binary to binary-decimal form.

See also:—
Applications, Military: Ref. 2054.

ELEMENTS

1937 **Associative self-sorting memory.** R. R. Seeber, *Proc. Eastern Joint Computer Conference,* 1960, 179-187. In this paper, a memory system is proposed which is organised to achieve sorting within the memory. It is an associative memory in which the status of a memory word is determined, with respect to an interrogating word, on a high, low or equal basis. Thus, the bracketing pair of words is determined, allowing the interrogating word to be inserted between them, a 'dummy' register holding it temporarily. A double-shuffle operation moves the other words to make room for the new word in proper sequence. Cryotron circuitry, which is ideally suited to such a memory, is described. 2 refs.

1938 **Audio programmer.** J. M. Ellul, A. E. Lowe and F. O. Pearson, *IBM Technical Disclosure Bull.*, **4,** July 1961, 23-24. Description of equipment for use in the wiring of magnetic core memory planes, and which is designed to assist the operator when the number on a core is obscured by windings. The equipment includes the operative combination of a tape recorder carrying the wiring instructions, a keyboard with a key for each core position, a jig for holding the plane, and two grids each containing contacts aligned with each core position.

1939 **Bistable systems of differential equations.** J. Moser, *Ordinary Differential Equations Proc.*,* 320-329. Two bistable circuits are briefly described and their corresponding differential equations are given. The circuits are Goto's so-called twin circuit containing two Esaki diodes and a more complicated circuit based on the twin circuit. The solution of the differential equations is discussed and criteria are presented which ensure that all solutions tend to steady state solutions. The stability of the steady state solutions is discussed and the results are applied to the two circuits.

1940 **Calculated waveforms for the tunnel diode locked-pair circuit.** D. R. Crosby and H. R. Kaupp, *Proc. Eastern Joint Computer Conference,* 1960, 233-240. This paper provides an introductory analysis of the tunnel diode locked-pair circuit and waveforms obtained with the aid of a digital computer are presented. 5 refs.

1941 **Delayed single shot.** K. M. Trampel, *IBM Technical Disclosure Bull.*, **4,** July 1961, 53-54. Describes a single shot circuit which, after a well defined time delay, renders an output pulse having an accurately controlled width. The circuit employs transistors and a delay line.

1942 **Electroluminescent latch.** H. R. Foglia, *IBM Technical Disclosure Bull.*, **4,** July 1961, 64. Phospherescent materials such as Zn, Cd and Cu exhibit a change in dielectric constant when illuminated. Combining this change with the property of self-electroluminescence enables the described latch circuit to be provided.

1943 **Elements and units of ferrite-transistor cell one-cycle parallel arithmetic device of digital computer.** M. I. Petrukhin, *Automatika i Telemekhanika,* **22,** No. 2, 1961, 199-208 (In Russian) English summary: 'There are considered some principles of designing one-cycle circuits of delay elements, a symmetric output trigger, a shift register and of a counter-type adder for a ferrite-transistor cell parallel arithmetic device.' 4 refs.

1944 **Full binary adder with one tunnel diode.** B. Rabinovici and C. A. Renton, *Proc. IRE,* **49,** July 1961, 1213-1214. Letter describing a full binary adder in which a single tunnel diode and three resistors are arranged in a Wheatstone bridge network.

* For full title see Ref. 2103.

1945 **Latching threshold detector.** D. P. Brown and J. C. Rogers, *IBM Technical Disclosure Bull.*, **4,** July 1961, 45-46. Description of a threshold detector circuit employing transistors which latches up when the threshold of the circuit is reached or exceeded.

1946 **Magnetic cores, characteristics and application.** R. Stuart-Williams, *Auto. Control*, **15,** July 1961, 37-43. The fourth in a series of articles (for others see *C.A.*, **5,** Refs. 1205, 1460 and 1672) designed to provide reference material for engineers concerned with the design and application of magnetic core storage and switching units. This article deals with large, general purpose, random-access storage units and smaller, special purpose or buffer storage units employing magnetic core matrices.

1947 **Memory units of electronic digital computers.** V. M. Glushkov and L. A. Pilkevich, *Automatika*, No. 5, 1960, 23-32. (In Russian) English summary: 'Various memory units and their principal comparative characteristics are discussed in this paper. A brief description is given of ferromagnetic tape memory units, ferroelectric memory units and memory units with elements using the superconductivity effect. Particular attention is paid to problems of using ferromagnetic tapes 1000-2000 Å thick to design superhigh-speed operative memory units. Two variations of a ferromagnetic tape design with a switching time of 70 μsec are described.' 15 refs.

1948 **Parallel BCD adder.** W. S. Ang, *IBM Technical Disclosure Bull.*, **4,** July 1961, 41. Description of an adder for effecting parallel addition of binary coded decimal (BCD) numbers without carry propagation delays.

1949 **Parallel tunnel diode.** E. J. Rymaszewski, *IBM Technical Disclosure Bull.*, **4,** July 1961, 55-56. Description of a circuit employing two tunnel diodes in parallel and poled in opposite directions which has an improved negative resistance characteristic and has three stable states.

1950 **TCA inverter.** A. J. Gruodis and W. H. McAnney, *IBM Technical Disclosure Bull.*, **4,** July 1961, 57. Description of a circuit employing tunnel diodes and transistors which operates asynchronously as an inverter in response to ternary coded information.

1951 **Transistor-tunnel diode inverter.** J. R. Turnbull, *IBM Technical Disclosure Bull.*, **4,** July 1961, 52. Description of an inverter circuit employing the composite volt-ampere characteristic of a tunnel diode shunted by a resistor to obtain a constant current portion which limits the emitter current of a transistor, providing well-controlled output levels without saturating the transistor.

1952 **100-Mc tunnel-diode ring counter.** F. P. Heiman, *Proc. IRE*, **49,** July 1961, 1215. Letter describing a ring counter consisting of a series of bistable tunnel diode AND circuits connected in a ring with a small delay between each stage. 3 refs.

1953 **Tunnel diode switching circuit.** H. P. Wolff, *IBM Technical Disclosure Bull.*, **4,** July 1961, 42-43. A tunnel diode switching circuit which employs a pair of backward diodes to improve its operating performance and reliability is described. The application of the circuit in a memory is also described.

1954 **Tunnel diode switching circuits.** C. H. Stapper, *IBM Technical Disclosure Bull.*, **4,** July 1961, 44. Describes how the employment of a capacitor and a signal source in a parallel circuit arrangement with a tunnel diode improves the switching efficiency of the tunnel diode as compared to a circuit using a resistive element. The use of the circuit as a memory cell is described.

1955 **Twin tunnel diode inverter circuit.** D. B. Eardley, *IBM Technical Disclosure Bull.*, **4,** July 1961, 47. Description of a circuit which utilises the combined volt-ampere characteristics of two tunnel diodes along with a transistor to obtain signal inversion with large voltage gain.

1956 **Twistor memories.** P. N. McCabe, *Instr. & Control Systems*, **34,** July 1961, 1242-1245. An account is given of the wrapped twistor (a thin, narrow tape or wire of magnetic material wrapped in the form of a helix on a copper conductor), its characteristics, manufacture, operation and use in memory arrays. 3 refs.

1957 **A two transistor ternary inverter.** K. M. Trampel, *IBM Technical Disclosure Bull.*, **4,** July 1961, 48-49. Description of an inverter circuit employing two transistors, which inverts a signal residing in either one of two voltage levels and merely passes a third voltage level. The two voltage levels are '0' and '1' and the third, which lies between the other two, is defined as 'N' or nothing.

1958 **Neuristor studies.** H. D. Crane, Stanford University, *PB 149564*, 11 July 1960, 202 p., $14.00. Potentialities of the neuristor are explored for use in the construction of an electronic computer in which good conductors, or wires, are not available for carrying signals. A neuristor is defined as a device having the form of a one-dimensional channel along which signals may flow, the signals taking the form of propagating discharges having the following properties: (1) threshold stimulability; (2) uniform velocity of propagation; (3) attenuationless propagation; and (4) refractory period following the passage of a discharge, after which the neuristor can again support a discharge. Two devices are cited as members of this class: the common chemical fuse, and the axon process (nerve fibre) of a neuron. An investigation is presented of the logical power and development of specific techniques of logic realisation using neuristors. To develop neuristor networks, the allowed modes of interconnection of such devices must be specified. Two basic types of junctions are indicated; a T junction and an S junction. All network synthesis is then a game on these two (junction) symbols. The game and logical possibilities are studied in detail. It is shown that, in addition to realising all of the conventional logic network properties with neuristors, properties not having simple direct analogues may also be realised. Two properties of importance are: (1) the ability to realise any nonplanar logic network on a two-dimensional physical structure, and (2) the ability to obtain controllable probabilistic gate structures with exactly the same basic neuristor device. 14 refs.

1959 **Techniques for pulse testing magnetic film memory elements.** A. H. Anderson and T. S. Crowther, M.I.T., *AD-255698*, 29 Jan. 1960, 1 v., $2.60. Equipment and procedures have been developed for testing the individual magnetic film elements of an integral array. Each element is tested for switching output amplitude, digit and transverse disturb sensitivity, and skew of the easy axis. The array of the magnetic film elements is mechanically indexed under a single set of drive lines and sense coil, one element being tested at a time. The individual components of a testing station, manipulator, drive lines and sense coil, pulse generators, pattern generating logic, and sense amplifier are described.

1960 **Data storage device.** Int. Computers & Tabulators Ltd., *B.P. 873367*, 26 July 1961. This patent describes a data storage device employing a member possessing magnetostriction and magnetic remanence and which requires the simultaneous application of a magnetic field and a mechanical stress to change it from one state of magnetic remanence to another.

1961 **Analogue dividing circuit.** Electric & Musical Industries Ltd., *B.P. 873509*, 26 July 1961. A valve circuit, which could be used in a function generator, is designed to produce an output proportional to the ratio of two applied voltages or currents.

1962 **Data storage system.** Zuse K.-G., *B.P. 873627*, 26 July 1961. The magnetic core circuitry for serial storage of binary data described in *B.P. 871714* (*C.A.*, **5,** Aug. 1961, Ref. 1684) is provided with arrangements to facilitate the shifting of numbers within a row of the matrix.

1963 **Magnetic core logical circuit.** Int. Business Machines Corp., *U.S.P. 2978176*, 4 April 1961. This patent is concerned with a logical circuit employing a multipath magnetic core, and also describes a single core circuit for a full binary adder.

1964 **Analogue multiplier/divider.** Sun Oil Co., *U.S.P. 2978178*, 4 April 1961. Diode circuits are described which perform multiplication and/or division with high accuracy and good frequency response.

1965 **Difunction multiplier.** Litton Industries Inc., *U.S.P. 2978179*, 4 April 1961. This patent describes a difunction multiplier which generates a difunction output signal representative of the product of two quantities respectively represented by an analogue multiplicand signal and a difunction multiplier signal.

1966 **Magnetic core flip-flop.** Int. Business Machines Corp., *U.S.P. 2978593*, 4 April 1961. A bistable or flip-flop circuit is described which employs magnetic cores but does not require diodes.

1967 **Magnetic core memories.** Sperry Rand Corp., *U.S.P. 978681,* 4 April 1961. This patent is concerned with construc-ional features of and methods of assembling three-dimensional .rrays of magnetic cores.

1968 **Magnetic core logic circuits.** Gen. Electric Co., *U.S.P. 2978684,* 4 April 1961. Circuit arrangements are described for suppressing noise or 'sneak' pulses in the output of a magnetic core logic circuit.

1969 **Serial binary adder.** North American Philips Co., Inc., *U.S.P. 2979261,* 11 April 1961. Magnetic core circuitry for serial addition of two binary numbers is described.

1970 **Magnetic core circuits.** Sperry Rand Corp., *U.S.P. 2979698,* 11 April 1961. Magnetic core circuits are described with improved operating characteristics, and capable of being used as gates, buffers and function tables.

1971 **Counting circuit.** Int. Business Machines Corp., *U.S.P. 2979703,* 11 April 1961. A counting circuit employing magnetic cores and its use as a stage in a decimal counter are described.

1972 **Digital multiplier.** Int. Business Machines Corp., *U.S.P. 2981470,* 25 April 1961. This patent describes in some detail a multiplier which handles words of variable length and 'tailors' the multiply operation to the particular values being multiplied. A product is developed by multiplying each digit of the multiplicand on a serial digit-by-digit basis by a digit of the multiplier to form a partial product which is added, with proper column shift, to the previously formed partial product.

1973 **Magnetic memory device.** Bell Telephone Labs., Inc., *U.S.P. 2981932,* 25 April 1961. This patent is concerned with the construction of a magnetic memory device and of a matrix of such devices, the device comprising a globule of ferrite material in which are embedded, wires insulated from each other and the ferrite material.

1974 **Multistable superconductive circuit.** Int. Business Machines Corp., *U.S.P. 2981933,* 25 April 1961. A multistable circuit includes a thin superconductive film with apertures therein and magnetic field-producing means operative to selectively establish a magnetic field which links certain apertures.

1975 **Trigonometric function generator.** Gen. Precision Inc., *U.S.P. 2983448,* 9 May 1961. This patent describes a circuit for generating trigonometric functions, which employs only three basic components: a linear voltage divider or potentiometer, a resistor and an amplifier.

1976 **Binary counter.** Sperry Rand Corp,. *U.S.P. 2983826,* 9 May 1961. A binary counting circuit is described in which the input is supplied to an EXCLUSIVE-OR element whose output is delayed and coupled back to its other input; the delayed output together with the input is also supplied to an AND element whose output provides the count. Preferably magnetic cores are employed.

1977 **Switching circuit.** Compagnie des Machines Bull, *U.S.P. 2983828,* 9 May 1961. A switching circuit features the combination of a transistor flip-flop and a magnetic core, the state of which is changed by the current selectively controlled by one of the flip-flop transistors.

1978 **Superconductive device.** Radio Corp. of America, *U.S.P. 2983889,* 9 May 1961. A bistable superconductive device of the persistent current type, employs two portions of superconducting materials with one portion having a higher critical magnetic field than the other.

1979 **Binary comparator.** Gen. Electric Co., *U.S.P. 2984821,* 16 May 1961. A circuit employing switching stages is described which effects simultaneous comparison of all the digits of two binary numbers to determine the greater of the two numbers.

1980 **Magnetic matrix storage system.** Laboratory for Electronics Inc., *U.S.P. 2984825,* 16 May 1961. A matrix type data storage system is described in which the magnetic field associated with two or more walls separating oppositely oriented domains is used to divide a data storage medium into an ordered arrangement of magnetised areas representative of the data.

1981 **Gating circuit.** Thompson Ramo Wooldridge Inc., *U.S.P. 2984826,* 16 May 1961. A gating circuit, suitable for use in a disjunctive tree matrix for selecting magnetic heads, includes a signal path having a pair of impedance elements (such as diodes) whose sum value is variable between very low and very high values, and a bias path arranged in shunt with the signal path and containing a similarly variable impedance element.

1982 **Electro-optical counter.** Int. Business Machines Corp., *U.S.P. 2985763,* 23 May 1961. A binary counter is described in which digit-representing light pulses are processed by electrically interconnected photoconductors and electro-luminescent spots.

1983 **Shift register.** Int. Business Machines Corp., *U.S.P. 2985867,* 23 May 1961. A decimal shift register employs multistable magnetic cores.

1984 **NEITHER NOR logical element.** Int. Business Machines Corp., *U.S.P. 2985868,* 23 May 1961. A circuit employing magnetic cores is designed to perform the NEITHER NOR logical function.

ANALOGUE

1985 **The iterative analog—low-cost speed for information processing.** R. K. Stern, *Control Engng.,* **8,** July 1961, 117-121. The advantages of iterative analogue computers, such as DYSTAC (Dynamic Storage Analog Computer), over digital and conventional analogue computers are explained. The following examples of applications where high speed iterative analogue techniques are particularly advantageous are discussed: radar aiming; multi-tray distillation tower computations; solution of partial differential equations; multiple integration; hydrodynamic problems; optimisation of petroleum production; development of mathematical models of processes; optimisation of process operating conditions; on-line optimising control; business inventory control. 13 refs.

1986 **A Pulsed Analog and Digital Computer for function generation.** J. H. Binsack, M.I.T., *PB 154904,* Oct. 1960, 116 p., $9.60. A Pulsed Analog Computer has time-shared analogue computing elements. Previously, a family of high-speed pulsed analogue computing elements (operational amplifier, decoder, sample and storage gates, etc.) capable of operation in 10 microsec. was developed. Tests of these elements are described under the control of a program stored in the memory of a general purpose digital computer, the TX-O. The combined system, which includes a sequential digital machine to assist in the interpretation of this stored program and the transfer of data between the analogue and digital domains, is called the Pulsed Analog and Digital Computer (PADIC). Sequential analogue operations can be performed at a rate of 80,000 per second, with accuracies approaching 1 per cent. The design procedures can be used for construction of larger systems for any purpose. As a test problem, the generation of an arbitrary function of a single variable stored as discrete points in the digital memory was accomplished using the experimental PADIC system and compared with the digital solution. Each pulsed-analogue function interpolation was completed in 162 microsec. including memory accesses and this time can easily be reduced. 20 refs.

DIGITAL

1987 **The 2400 for balanced I/O.** W. Patterson, *Datamation,* **7,** July 1961, 44-45. Brief account of the main features of the Philco 2400, an auxiliary and input/output processor for use with the Philco 2000.

1988 **A description of the IBM 7074 system.** R. R. Bender, D. T. Doody and P. N. Stoughton, *Proc. Eastern Joint Computer Conference,* 1960, 161-171. An account of the IBM 7074 data processing system in which it is compared with the IBM 7070 on which it is an improvement. Increased performance is achieved by the use of a new, high performance arithmetic and program unit and improved-performance storage units operating on a 4 microsecond cycle instead of the 6 microsecond cycle of the basic 7070. 1 ref.

1989 **The instruction unit of the Stretch computer.** R. T. Blosk, *Proc. Eastern Joint Computer Conference,* 1960, 299-324. This paper is concerned with the instruction unit (or I unit) which was developed as the largest portion and the major control unit of STRETCH. A complete description of the major functional requirements is given along with some examples of the difficulties encountered. The machine organisation, including data paths and controls, is described and many of the primary design considerations are discussed. The complexity and size of the unit are largely determined by the instruction buffering, fast access index registers, the extensive overlapping and simultaneity of operations and the innumerable combinations and variations of instruction sequences that have to be controlled. The control is achieved by a synchronous clock controlled network of variable sequence execution control stages. The performance is shown for a few typical and particularly important operations. refs.

1990 **The L-3060.** *Datamation,* **7,** July 1961, 46. Brief account of the L-3060, a parallel binary computer developed by the Librascope Division of General Precision Inc., for real-time control applications.

1991 **The Magnacard system.** R. E. Westgard, *Datamation,* **7,** July 1961, 42-43. General description of the Magnacard system, a general purpose data processing system with the special feature of being able to store, search and update large masses of data at high speeds. The basic system consists of: the magnetic card with a capacity of 756 alphanumeric characters; transport and control units for sorting, file updating and searching; Magnacard file storage units providing access in seconds to 900.000 magnetic cards; central processor, a general purpose digital computer with 4,096 12-bit words of core memory and an add time of 12.8 microseconds; input-output equipment; and the Magnascriber which permits the key-driven recording of data on the magnetic cards.

1992 **PB 250—a high-speed serial general purpose computer using magnetostrictive delay line storage.** R. M. Beck, *Proc. Eastern Joint Computer Conference,* 1960, 283-297. This paper presents the design objectives of the PB 250, a general purpose computer which is intended to serve as a component in special purpose systems. Some of the design considerations applied toward meeting these objectives are also presented. The significance of the use of magnetostrictive delay memories in a low-cost computer as well as the approach used to minimise the active elements in a flexible computer input/output system are discussed.

1993 **The RCA 601.** K. Kozarsky and A. Mendelsohn, *Commun. ACM,* **4,** April 1961, 197-199. An account of the main features of the RCA 601 digital computer system.

1994 **The RCA 601 System design.** A. T. Ling and K. Kozarsky, *Proc. Eastern Joint Computer Conference,* 1960, 173-177. This paper discusses the system logic design of the RCA 601 System and gives an account of some hardware and programming features.

1995 **Mobile digital computer program MOBIDIC B. (Addendum).** E. W. Jervis, Sylvania Electronic Systems, *AD-256160,* 7 Dec. 1960, 1 v., $9.10. This report describes three mechanised instructions (multiply, multiply and round, shift left long) and their mechanisation, the mass memory and mass memory control unit (including the mass memory address register), and the mass memory controls in the van and in the remote truck.

1996 **Digital differential analyser.** University of Utah, *U.S.P. 2982470,* 2 May 1961. This patent describes a digital differential analyser with arrangements for introducing empirical information in digital form from a permanent record such as a tape.

1997 **Binary computer.** H. D. Huskey, *U.S.P. 2982472,* 2 May 1961. A description is given of a small, high-speed, general purpose digital computer operating in binary and employing a magnetic drum memory, which has comparatively high data processing capacity.

See also:—
Analogue: Ref. 1986.

PROGRAMMING

1998 **ALGOL 60 confidential.** D. E. Knuth and J. N. Merner, *Commun. ACM,* **4,** June 1961, 268-272. It is suggested in this paper that ALGOL has been made unnecessarily difficult to use because so many restrictions have been lifted that a lot of technical details crop up which are hard to learn and to use correctly. Some of the more obscure features of the language are considered and their usefulness is discussed. The authors conclude that 'In some respects the ALGOL language seems to us to be more general than necessary. A certain amount of generality is essential to express algorithms, but extra things which are not needed have been put in, and they serve only to confuse the man trying to learn the language and to give more headaches to the people writing ALGOL translators.' The authors want at least the following portions of ALGOL 60 undefined: the order in which components of an expression are evaluated; numeric labels; going to an undefined switch designator; and 'local' interpretation of **own** variables. 9 refs.

1999 **On the compilation of subscripted variables.** R. E. Nather, *Commun. ACM,* **4,** April 1961, 169-171. Description of a compiler for the RPC-4000 which accepts FORTRAN II source language and is based on the complete evaluation of the 'storage mapping function' so as to avoid any severe limitations on the form of subscripts. 8 refs.

2000 **Computer generation of optimized subroutines.** H. H. Denman, *J. Assn. Computing Mchy.,* **8,** Jan. 1961, 104-116. A method is presented by means of which a digital computer may be programmed to generate subroutines to be used for function evaluation in other computer programs. The approximation formula used in these subroutines is nearly the optimum polynomial approximation (in the Chebyshev sense) for that function in a given arbitrary interval. Results are presented for an IBM 650 program that finds the Chebyshev expansion coefficients for the functions $\sin \gamma x$, $\cos \gamma x$, $e^{\gamma x}$, $\sinh \gamma x$, and $\cosh \gamma x$. 9 refs.

2001 **Corrections to Sattley paper in January Communications.** K. Sattley, *Commun. ACM,* **4,** May 1961, 211. Letter correcting errors in the author's paper 'Allocation of storage for arrays in ALGOL 60', *ibid,* **4,** Jan. 1961, 60-65 (*C.A.,* **5,** June 1961, Ref. 1282).

2002 **On Grau's recursive processes and on compiling expressions in ALGOL.** G. A. Bachelor, *Commun. ACM,* **4,** June 1961, 252-253. Letter pointing out that in certain ALGOL expressions it is not possible to tell from the context whether a variable is Boolean or arithmetic and suggesting a change in ALGOL to overcome this difficulty. In addition, some corrections are suggested to the paper 'Recursive processes and ALGOL translation', A. A. Grau, *ibid,* **4,** Jan. 1961, 10-15 (*C.A.,* **5,** June 1961, Ref. 1271).

2003 **Iron's procedure DIAGRAM.** B. H. Mayoh, *Commun. ACM,* **4,** June 1961, 284. Letter suggesting some corrections to 'A syntax directed compiler for ALGOL 60', E. T. Irons, *ibid,* **4,** Jan. 1961, 51-55 (*C.A.,* **5,** June 1961, Ref. 1279).

2004 **Minimizing drum latency time.** D. E. Knuth, *J. Assn. Computing Mchy.,* **8,** April 1961, 119-150. This paper is concerned with the minimisation of drum latency time, i.e. the optimisation of the placements of locations of instructions and data on a drum so as to minimise program running time. Optimisation is used in this paper as meaning not merely the determination of best drum locations, but the polishing of a piece of coding in machine language, to minimise its running time, such that the basic structure (flow chart) behind the coding remains unchanged, but certain alterations in the order or form of the instructions are allowed. Use is made throughout the discussion, as an example, of an IBM 650 routine for floating-point addition. Results obtained with various optimising methods are compared. A mathematical solution to the latency minimisation problem is developed and the application of integer programming techniques is discussed. Finally, it is shown that the most practical way for minimising latency is to do the job by hand with a semi-systematic procedure and to use computers for the routine phases and for checking the human output. 10 refs.

2005 **"Open shop" programming at Rocketdyne speeds research and production.** D. J. Breheim, *Computers & Automn.*, **10,** July 1961, 8-9. General account of the arrangements at Rocketdyne Division of North American Aviation Inc., whereby engineers write their own FORTRAN programs for an IBM 709 and IBM 7090.

2006 **Operational compatability of systems—conventions.** G. F. Ryckman, *Commun. ACM*, **4,** June 1961, 266-267. The General Standards Committee of the SHARE organisation has devoted considerable effort to the problem of operating a computer efficiently in view of the growing number of programming systems. (A system is defined as a compiler, assembler, interpreter or any large general purpose program). Each of these programming systems has been coded to utilise a fixed set of hardware components without recognising the fact that others may be occupying a storage medium required by the first. These incompatibilities are currently resolved by manually setting up the computer for each system as required. This paper presents a set of conventions which is being considered to minimise computer set-up time.

2007 **System handling of functional operators.** L. Lombardi, *J. Assn. Computing Mchy.*, **8,** April 1961, 168-185. This paper is concerned with the problem of using free operators, i.e. operators which are defined independently of their operands, in scientific machine languages. It is shown that the implementation of programming systems able to handle free operators is the first of many steps that have to be taken in order to construct systems able to bridge the wide gap existing between the way scientists state problems and the program to which these problems must be reduced to be accepted by the compilers of current use. The approach proposed in this paper is based on an expansion, rather than a translation, of the source program. The main feature of the approach is described by the following sentence: A free operator can not be expanded into the machine language until it is provided with its operands. Use is made throughout of examples in FORTRAN. 16 refs.

2008 **Theory of programmed processes.** T. N. Hibbard, *Commun. ACM*, **4,** April 1961, 195. Brief account of research at System Development Corporation in the theory of programmed processes, the term *programmed process* denoting a program at work, as distinguished from a program in some other state such as compilation, checkout or translation.

2009 **The trouble with commercial compilers.** J. H. Hughes, *Computers & Automn.*, **10,** July 1961, 13-14. The author suggests that the use by business programming languages of English words is not, as often claimed, their principal virtue, but that their chief weakness is, in fact, their attempted use of English. It is proposed that efforts of people working on English language compilers should be diverted to work on compilers for a new language designed to have the advantages of English without its disadvantages.

2010 **ALGOL 60 procedures for range arithmetic.** A. Gibb, Stanford University. *AD-255656,* 12 April 1961, 9 p., $1.60.

2011 **Symbol manipulation by threaded lists.** A. J. Perlis and C. Thornton, Carnegie Inst. of Tech., *AD-233298 (PB 153773),* 1 March 1960, 38 p., $3.60. This appears to be the same as the paper in *Commun. ACM*, **3,** April 1960, 195-204 (*C.A.*, **4,** July 1960, Ref. 1295). 4 refs.

2012 **On the syntax machine and the construction of a universal compiler.** A. E. Glennie, Carnegie Inst. of Tech., *AD-240512 (PB 149793),* 10 July 1960, 67 p., $6.60. The problem of many problem-oriented languages to be translated to many machine languages is considered. A mechanism for scanning a linear text and performing a syntactic analysis is proposed. A pseudo-machine, the syntax machine, whose programs may be considered to define the language of the text, is described. The output from the syntax machine is a string whose evolution leads to a (partial) translation of the source text. The application of the syntax machine to translation for a particular target-machine language is discussed, and how the syntax description may be written to exploit the special feature of the target machine is shown. Consideration is given to the role of declarations in the source language and the mechanisms required to effect them in the translation process. A supplementary process of assembly required to evaluate the strings produced by the syntax machine is investigated. 1 ref.

2013 **Transformation rules and program simplification.** T. G. Evans and T. Marill, Bolt Beranek & Newman Inc., *AD-251083 (PB 154558),* 7 Feb. 1961, 27 p., $2.60. Consideration is given to an approach to the problem of program simplification. The essential idea is to perform manipulations, through a set of transformation rules, on a given class of function-representing expressions (called F-expressions), thereby producing equivalent F-expressions from which "better" programs may be generated. The first part of the report defines the F-expressions and discusses in general terms the process of using transformation rules to perform a systematic search for the "best" F-expression equivalent to the given one. The remainder of the report is devoted to an application of this scheme to one special class of problems. An advantageous procedure for converting F-expressions to programs is discussed, and a set of examples illustrative of the computational savings possible through the use of this scheme is given.

See also :—
Design: Ref. 1813.
Techniques: Ref. 1907, 1908 and 1910.
Applications, Miscellaneous: Ref. 2089.

APPLICATIONS

AERO- AND ASTRONAUTICAL

2014 **Lösung des dreidimensionalen Vierkörperproblems: Sonne, Erde, Mond und Raumschiff.** (Solution of three-dimensional four body problems: Sun, Earth, Moon and Spaceship.) P. Lesky, *Ordinary Differential Equations Proc.**, 1960, 15-21. (In German) The four body problem is discussed and two methods of solution are presented. 2 refs.

2015 **Analog-computer investigation of effects of friction and preload on the dynamic longitudinal characteristics of a pilot-airplane combination.** H. L. Crane, NASA, *AD-255956,* May 1961, 47 p., $1.25. With an analogue computer, an investigation was made of the effects of stick pivot friction and servo valve friction on the longitudinal response of a fighter aeroplane.

2016 **Calculations of the one-dimensional nonequilibrium flow of air through a hypersonic nozzle.** W. G. Vincenti, Stanford University, *AD-256239,* May 1961, 41 p., $4.60. A method is described for numerical calculation of the one-dimensional nonequilibrium flow of a nitrogen-oxygen mixture through a converging-diverging nozzle. First, the general equations are set down for a mixture of perfect gases with an arbitrary number of species undergoing an arbitrary number of chemical and vibrational rate processes. The method of calculation is then described, including a perturbation process used to obtain the required initial conditions for the nonequilibrium computations. Specific calculations, carried out on an IBM 709, are then reported for an air model consisting of O_2, O, N_2, N and NO and including eight chemical reactions plus the vibrational processes of three diatomic species. 25 refs.

2017 **Calculation of the radial distribution of the density dependent properties in an axisymmetric gas stream.** M. T. Dooley and W. K. McGregor, Arnold Air Force Station, *AD-256777,* May 1961, 30 p., $2.60. An analytical method of determining the radial distribution of the density dependent properties in an axisymmetric gas stream is presented. This method is used to invert the integrated lateral intensity distribution of properties which are normally obtained with experimental techniques to the desired local radial variation. The equation of lateral distribution is derived, and the analytical solution for the radial distribution equation is shown. A numerical solution ideally suited to high speed digital computers is presented.

2018 **Digital programs for calculating the pressure distribution over two-dimensional bodies and the determination of streamlines and heat transfer coefficients for blunted cones at angle of attack.** G. Weilerstein and J. Hoffman, Gen. Appld. Science Labs., Inc., *AD-256187,* March 1961, 51 p., $5.60. A program, written for use with the IBM 7090 FORTRAN monitoring system, for calculating pressures along a two-dimensional body is described. Local, asymptotic, blast wave and viscous pressure are calculated at stations along the body using a modified Creager-Blast Wave Analysis. For each body the angle of attack can be varied over 20 different values and the free stream conditions can be varied over 50 different sets of values. A program is also described which permits an engineering analysis of the laminar heat transfer on a spherically blunted cone at angle of attack for hypersonic flight speeds. As part of the analysis, the surface streamlines on the cone are generated. The program is written assuming an ideal gas.

* For full title see Ref. 2103.

2019 **General description of IBM 704 computer programs for ow field about blunt-nosed bodies of revolution in hypersonic ight.** E. Lieberman, Gen. Appld. Science Labs., Inc., *AD-256186*, March 1961, 97 p., $9.10. The scope of these programs is to enerate the flow field about blunt-nosed axisymmetric bodies f revolution in hypersonic flight, including the effect of gas issociation and vibrational excitation. The flow field about the ubject category of bodies includes a subsonic and a supersonic ortion. The calculations proceed by an inverse method (pre- cribed shock) in the subsonic region, and by characteristic rocedures in the supersonic region. For a given body shape, he subsonic region is determined first by iteration; the numerical nalysis is then continued in the supersonic region for the pre- cribed body shape. The equations which constitute the analysis which has been programmed, are included for descriptive purposes.

2020 **Lunar trajectory studies and an application to Lunik III trajectory prediction.** A. Petty and I. Jurkevich, General Electric Co., *AD-255000*, July 1960, 1 v., $9.10. A summary is given of technical accomplishments pertaining to three relatively closely connected areas: (1) design of a fast, accurate, and efficient program for computation of lunar trajectories; (2) an application of the resulting program to an error analysis of specific lunar trajectories and to the determination of some actual trajectories (as an example the trajectory of LUNIK III is considered in detail) ; and (3) tracking program (determination of initial conditions to be used in the equations of motion). 12 refs.

2021 **Numerical construction of transonic flows past blunt bodies of revolution.** E. W. Schwiderski and E. L. Poole, Naval Weapons Lab., *AD-250708 (PB 154434)*, 11 Jan. 1961, 158 p., $11.50. A detailed description, including flow diagrams, is given for constructing transonic flow elements by the method of generalised grid schemes and generalised finite differences. The computing program allows for the influence of real gas effects across the shock wave and for the specification of free stream Mach numbers ranging from 1.2 up. The shock wave is prescribed as the arc of an ellipse, hyperbola, or parabola with allowances for the perturbing effects of fourth degree algebraic terms. The average NORC computing time per case is fifty seconds. Forty-one different cases are given in tabular and/or graphical form. 2 refs.

2022 **A technique for computing three-dimensional steady inviscid supersonic flows.** G. Moretti, Gen. Appld. Science Labs., Inc., *AD-256179*, 11 July 1960, 28 p., $2.60. A thorough understanding of the supersonic flow past an arbitrarily shaped body can only be achieved by solving the 3-dimensional aerodynamic problem. Only numerical techniques can be used because of the nonlinearity of the equations, but a quick panoramic survey of a problem is often more useful than the exact solution in one particular case. An attempt has therefore been made to develop a technique for use on a small computer. Its advantages are: the simplicity of the program; direct control of the results; choice of different degrees of approximation, including a very rough one. In this report, the essential features of the problem are first examined and then the numerical procedure which has been set up and programmed is outlined.

See also:—
Accessories: Ref. 1931.
Military: Ref. 2058.
Simulation: Ref. 2087.

BUSINESS

2023 **Control by computer of 30,000 G.P.O. items.** A. A. McPhie, *Automn. Progress*, **6,** July 1961, 234-237, 246. This article describes the introduction of punched card equipment followed later by a computer (ICT 1201) for control of G.P.O. stores for the maintenance and development of the telecommunications system. The stores amount to some 30,000 items. One of the features of the data processing system is the preparation of information which facilitates the work of provisioning officers in maintaining adequate but not excessive supplies.

2024 **Information system controls plant over 500-mile data link.** R. H. Bayer, *Control Engng.*, **8,** July 1961, 115-116. Account of the use by Electric Autolite Company of IBM's management operating (MOS) concept. Data processing functions are performed for the company's factory at Decatur, Alabama on an IBM 305 RAMAC at the Toledo, Ohio headquarters by means of an IBM 357 data collection system (at the factory) and a card-to-card data transmission system. The system provides for payroll and general accounting as well as production scheduling, inventory control and materials planning.

2025 **Invoicing stocks production—under control.** L. Trace, *Auto. Data Processing*, **3,** July 1961, 16-19. Outline of the data processing system, including two IBM 305 RAMAC computers, employed by C. and J. Clark Limited, shoe manufacturers, to process orders and control stocks and production.

See also:—
General: Ref. 1812.
Techniques: Ref. 1915.

CHEMICAL

2026 **The prospects for the utilization of informational-logical machines in chemistry (USSR).** L. I. Gutenmakher and G. E. Vleduts, *J. Assn. Computing Mchy.*, **8,** April 1961, 240-251. This is a translation from the Russian of a report to the Symposium at the Eighth Mendeleyev Congress on General and Applied Chemistry. An account is given of a 'chemical information machine' developed at the Laboratory of Electromodelling of the All-Union Institute of Scientific and Technical Information of the Academy of Sciences, U.S.S.R. This machine is designed to store and retrieve chemical literature. The coding of chemical compounds (structural formulae) and chemical reactions is described. Application to problems such as chemical structure searching and chemical synthesis searching (searching for reactions to synthesise a given compound) is discussed. 3 refs.

See also:—
Simulation: Ref. 2085*d*.

CONTROL—GENERAL SYSTEMS

2027 **A computer controlled dynamic servo test system.** V. A. Kaiser and J. L. Whittaker, *Proc. Eastern Joint Computer Conference*, 1960, 255-266. An account is given of Douglas Aircraft Company's system for automatic testing of missile flight control servo systems, which is controlled by an RW-300 digital control computer.

2028 **Computers in automatic control systems.** J. G. Truxal, Polytechnic Inst. of Brooklyn, *AD-251128 (PB 154557)*, 9 Nov. 1960, 43 p., $4.60. Modern automatic feedback control systems increasingly utilise flexible and highly developed electronic computers as active controllers. The trend from the use of simple electric circuits and elementary analogue devices toward high-speed digital computers (or computers employing both digital and analogue devices) is accelerated by: (1) the rapidly growing complexity of modern control systems; (2) the development of optimising control; and (3) the increasing importance of self-adaptive control. 11 refs.

2029 **Logical scheduling of a multiplexed digital controller.** E. W. Henry, *AD-241163 (PB 149814)*, 11 July 1960, 139 p., $10.50. Problems which arise when several dynamic processes are controlled simultaneously by a single digital computer are considered. Methods of synthesising a digital controller program for a cyclic-sampled system are derived. One design yields a system which exhibits an error transient of finite duration in response to polynomial inputs. Another procedure yields a controller which minimises a weighted quadratic function of the system error states and the process input energy. The latter design is extended to include control of multi-input processes. The digital controllers for these cyclic-sampled systems are described by linear difference equations with periodically time-varying coefficients. Both state-feedback and error-sampled systems are discussed. The scheduling of a multiplexed controller which maintains conventional constant period sampling for each process is discussed. Elementary concepts of number theory and combinatorial analysis are used to find all possible sets of sampling periods. Design considerations for an error-adaptive multiplexed digital controller are also discussed. Each process may operate in either a 'normal' or a 'disturbed' condition. The computer is programmed to change the various sampling periods as a function of these process conditions so that the over-all system performance is improved. Techniques are given for minimising transient effects which may arise when a process sampling rate is changed. 18 refs.

CONTROL—MACHINE TOOL

2030 **Automatic programming of numerically controlled machine tools.** D. T. Ross and H. E. Pople, M.I.T., *AD-120064 (PB 155516)*, 1957 (Released to public 1 June 1961), 57 p., $5.60. The possibilities are investigated of using a general-purpose digital computer for automatic programming of numerically controlled machine tools. Effort is concentrated on determining the basic principles involved in combining a human, a machine tool, and a computer into a flexible and efficient system. Initial stages of an APT system (Automatic Programmed Tool system) have been developed which embody a simulated APT computer which can be programmed by curves and regions. 3 refs. See also Refs. 2031 and 2032.

2031 **Automatic programming of numerically controlled machine tools.** D. T. Ross, S. M. Matsa et al, M.I.T., *AD-135665 (PB 155517)*, 1957 (Released to public 1 June 1961), 106 p., $9.10. Mathematical analyses are made for 2 automatic programmed tool (APT) techniques for numerically controlled machine tools. The APT II system for programming of 3-dimensional parts in terms of curves is a new design of a previous system. Programming by 3-dimensional surface regions is the first formal presentation of the APT III system. Derivations of auxiliary techniques employed in both systems are given which include calculations for curvature, length of trail-cut vector, values for cutter-centre offset, and check surface. See also Refs. 2030 and 2032.

2032 **Automatic programming of numerically controlled machine tools.** S. M. Matsa, M.I.T., *AD-156059 (PB 155518)*, 1958 (Released to public 1 June 1961), 125 p., $10.10. With the surface programming system described in the main body of the report, numerical control tapes for cutting three dimensional surfaces are produced by the Whirlwind computer from the parameters of surface equations, tool geometry, required tolerance and machine feedrate, all fed into the computer on the input typewriter. This program as described in the report is a prototype, and its development, based on project research activities, is still under way. A short account of the project participation in a cooperative computer programming effort with a number of aircraft companies is given in an appendix. 1 ref. See also Refs. 2030 and 2031.

See also:—
Engineering, Mechanical: Ref. 2041.

ELECTRONICS

2033 **On the general solution of some non-linear differential equation.** M. Goto, *Ordinary Differential Equations Proc.**, 1960, 403-422. Subharmonic oscillations occur in an ac circuit consisting of inductance, capacitance and resistance in series and various other types of non-linear oscillations occur under special conditions. Since the solutions of nonlinear differential equations are obtained only approximately in almost all cases, the existence of such nonlinear oscillations is not strictly proved. In this paper, by idealising the saturation characteristics of an iron core inductor in three linear parts, exact solutions in the LCR series circuit are obtained by connecting the solution of every circuit with linear characteristic. Results obtained include: the existence of undamped oscillations which are not periodic but nearly equal to the fundamental or subharmonic oscillations, their phases varying gradually; and the existence of undamped oscillations which, after lasting several cycles, fall into the ordinary transient state, approaching fundamental or subharmonic oscillations gradually.

2034 **A survey of digital methods for radar data processing.** F. H. Krantz and W. D. Murray, *Proc. Eastern Joint Computer Conference*, 1960, 67-82. This paper reviews the growing number of digital techniques for automatic processing of radar data. Emphasis is placed on signal time-sampling and quantisation, integration methods, rejection of stationary targets, radar trigger manipulation and treatment of radar beacon code data. These techniques are discussed individually and are also shown combined in a hypothetical radar data processor design.

2035 **Analysis of a VOR distance computer.** A. Tatz and A. D. Mehall, Airborne Instruments Lab., *PB 154517*, March 1960, 82 p., $8.10. Analogue computer techniques are used to simulate airborne equipment that will compute range from a VOR station while using the output of a single VOR receiver as the only available source of radio-navigation aid data. Starting from a known initial position, use is made of time derivatives of the bearing angle to the VOR station to compute a running value of distance derivative. The distance derivative is continuously integrated to yield constantly changing range to the VOR station. The computer simulation outputs of recorded distance as well as recorded intermediate quantities are documented in this report. Statistical analyses of the errors in computed distance are presented and their significance is discussed with respect to the application of the single VOR distance computer to area navigation methods.

2036 **Arbitrary delay equalization utilizing digital computer.** L.-H. S. Cheo, University of California, *AD-242549 (PB 150512)*, 5 July 1960, 46 p., $4.60. This report relates to network synthesis, beginning with a given specification of the behaviour of the network as a function of frequency. From this given specification, a network function is found, then the physical network can be realised. The task of obtaining the network function from the given specification is termed an approximation. A method is used to solve any delay problem by applying the least square technique, in which the IBM 704 is utilised to serve the iteration purpose. 2 refs.

2037 **IBM 704 FORTRAN program for evaluating semiconductor surface transport integrals.** E. G. Thomas, Naval Ordnance Lab., White Oak, *AD-255720*, Dec. 1960, 90 p., $9.10. In connection with a theoretical study of surface transport in semiconductors, numerical evaluation of the final mobility formula was required. This formula has the form of an integral of a transcendental function of an integral. Evaluation was required for a finite number of values of two parameters, one being the lower limit of the outer integral, the other occurring in the integrand of the inner integral. After removal of a singularity in the inner integral, both integrals were evaluated by Guassian quadratures. The evaluation was done on the IBM 704 using the FORTRAN program given in this report.

2038 **Transient response of some distributed parameter configurations. Part I.** D. Starner, Lockheed Aircraft Corp., *AD-245993 (PB 154605-1)*, Sept. 1960, 89 p., $8.10. A study of the transient response of particular distributed parameter networks is described. An exact analysis is presented for checking approximation methods. This analysis is also useful when extreme accuracy is required. Theoretical and experimental responses are compared and a computer program is given for evaluation of the theoretical responses. 4 refs.

See also:—
Design: Refs. 1815 and 1816.
Elements: Ref. 1940.
Military: Ref. 2056.
Simulation: Ref. 2085*e*.

ENGINEERING, ELECTRICAL

2039 **On iterative factorization in network analysis by digital computer.** W. H. Kim, D. H. Younger, C. V. Freiman and W. Mayeda, *Proc. Eastern Joint Computer Conference*, 1960, 241-253. The need to determine the sum of all tree admittance products occurs in almost all applications of topological network theory. This paper describes a method of obtaining this sum through an iterative factorisation of the sum of tree admittance products of successively more complex subnetworks. Computational efficiency is achieved in that: (1) it is not necessary to test sets of branches for the presence of circuits; and (2) it is not necessary to calculate each tree admittance product. A detailed description and flow chart of an IBM 704 program are included. The program accommodates any network with complex branch admittances and up to 14 nodes, but far more complex networks may be analysed if they are first decomposed into two-terminal subnetworks. 4 refs.

* For full title see Ref. 2103.

ENGINEERING, MECHANICAL

2040 **Combat vehicle firing stability (active suspension).** C. M. Fischer, *Commun. ACM*, **4,** June 1961, 279-283. This paper is concerned with the study at the United States Army Ordnance Tank-Automotive Command, of combat vehicle response during the firing cycle of main armament weapons. In keeping with the trend to mount larger calibre weapons upon chassis of reduced weight and decreased size, it is necessary to establish, with great accuracy, the firing stability of contemplated designs prior to extensive prototype development. The military vehicle, being a complicated dynamic system, will move in several different modes of motion simultaneously when disturbed by trunnion reaction of a fired weapon. The motion characteristics are derived and developed by application of Newton's laws for each degree of freedom. An analysis is given, of a general system, which establishes the equations to describe this engineering problem in a mathematical form sufficient for solution on a digital computer with the objective of resolving stability in terms of displacements, velocity and acceleration. 2 refs.

2041 **Computer-aided design.** D. T. Ross, *Commun. ACM*, **4,** May 1961, 235. Summary of work in progress at M.I.T. on a project comprising a programme of research into the application of the concepts and techniques of modern data processing to the design of mechanical parts and the further development of automatic programming systems for numerically controlled machine tools. 5 refs.

2042 **A numerical approach to some problems of continuum mechanics and related questions of stability.** G. Capriz, *Ordinary Differential Equations Proc.**, 1960, 510-529. This paper is concerned with a class of problems in mechanical engineering which cannot at present be studied rigorously but which can be approached in a sort of experimental spirit taking advantage of the potentialities of digital computers. The problems are concerned with the prediction of the slow plastic deformation (creep) in elastic bodies stressed at high temperature. The basic equations which describe the phenomenon of creep are discussed and an approximate method of stress analysis of an elastic system subjected to creep is presented. The calculations in particular cases are treated in some detail. These examples are: the flexure of a beam having rectangular cross-section under the action of constant couples; torsion of a circular shaft; and stress and strain in a thin rotating disc. Finally, instability in the calculations is discussed.

2043 **Finite difference analysis of the shock response of a packaged missile with nonlinear suspension mounts.** T. R. Beal, Lockheed Aircraft Corp., *AD-243856 (PB 154147)*, Sept. 1960. 30 p., $2.60. A method is described for obtaining solutions of vibrating systems with more than one degree of freedom which may readily be adapted to solution on a digital computer. 1 ref.

ENGINEERING, STRUCTURAL

2044 **KOAD-1—A digital program to calculate stresses and deflections in linear elastic structures under thermal distortion, pressure, and applied loads.** C. M. Friedrich, Bettis Atomic Power Lab., *WAPD-TM-243*, March 1961, 69 p., $2.00.

INFORMATION RETRIEVAL

2045 **The association factor in information retrieval.** H. E. Stiles, *J. Assn. Computing Mchy.*, **8,** April 1961, 271-279. This paper describes an all computer document retrieval system which can find documents related to a request even though they may not be indexed by the exact terms of the request, and can present these documents in the order of their relevance to the request. The key to this ability lies in the application of a statistical formula by which the computer calculates the degree of association between pairs of index terms. With proper manipulation of these associations (entirely within the machine) a vocabulary of synonyms, near synonyms and other words closely related to any given term or group of terms is derived. By noting the number of matching terms between this extended list of request terms and the terms used to index a document, and with due regard to their degree of association, documents are selected by the computer and arranged in their order of relevance to the request. 5 refs.

2046 **Automatic abstracting and indexing—survey and recommendations.** H. P. Edmundson and R. E. Wyllys, *Commun. ACM*, **4,** May 1961, 226-234. This paper introduces the relative-frequency approach to measuring the significance of words, word groups and sentences and discusses the use of this technique for the extraction of significant words and sentences in automatic indexing and abstracting. The basic concept is the use, as an indication of a word's value in indicating the subject matter of a document, of the contrast between the word's relative frequency f within the document and its relative frequency r in general use. Various functions of f and r for representing the contrast are considered and it is concluded that either $f-r$ or f/r is suitable. The paper then surveys and compares a number of methods that have been proposed for automatic abstracting and indexing. In conclusion, recommendations are made for the carrying out of further research in automatic abstracting and indexing. 7 refs.

2047 **The design and simulation of an information processing system.** H. M. Gurk and J. Minker, *J. Assn. Computing Mchy.*, **8,** April 1961, 260-270. This paper discusses a natural language information processing system with high input rate, a great variety of input, and requirements not only for interpretation, storage and retrieval of the data, but also for the logical processing, correlation and combination of the data to develop a different body of information for retrieval and analysis. The system has been designed by Radio Corporation of America as part of a study Project ACSIMATIC to determine the potential uses of data processing equipment and procedures in the activities of certain headquarters military intelligence operations of the U.S. Department of the Army. In addition to an account of the over-all design of the system, its simulation on an IBM 704 is described. 1 ref.

2048 **Information retrieval.** L. B. Doyle, *Commun. ACM*, **4,** April 1961, 195. Brief account of information retrieval research at System Development Corporation, directed mainly to document retrieval (as distinct from fact retrieval). 2 refs.

2049 **Pioneering in machine literature searching and information retrieval.** Naval Ordnance Lab., White Oak, *AD-255291*, April 1961. 22 p., $2.60. Papers presented at the sixth meeting of the Council of Librarians, East Coast Navy Labs., held at the Naval Ordnance Lab., 5 Oct. 1960. The first paper evaluates the experience at the American Society for Metals in machine searching versus conventional library reference searching and finds machine searching to be more effective. The mathematicians explain the direct and indirect file for organising library material for machine searches. Also discussed is the computer program adopted for the Naval Ordnance Lab. Library. In the final paper, the Library's use of the computer and some of the advantages are set forth.

See also:—
Chemical: Ref. 2026.

MECHANICAL TRANSLATION

2050 **Machine language translation study.** E. D. Pendergraft and L. W. Tosh, Texas University, *AD-255751*, 31 Jan. 1961, 1 v., $10.10. Progress is reported toward the development of a generalised computer system to implement translation of natural languages. The system will have two major functions: (a) a utility function that will compile, verify and optimise linguistic data of specific languages for the generalised translation algorithm, and (b) a production function to carry out the translation algorithm itself. Linguistic procedures being used in the preparation of German and English data for the system are described. Two appendices of these data are included. The beginning of a programme to improve the capabilities of the translation algorithm through mathematical research is explained.

2051 **Machine translation studies of semantic techniques.** Thompson Ramo Wooldridge Inc., *AD-256355*, 22 Feb. 1961, 1 v., $9.10.

2052 **Summary of the Proceedings of the Wayne State University Conference of Federally Sponsored Machine Translation Workers, held at Princeton Inn, Princeton, New Jersey, July 18-22, 1960.** Wayne State University, *PB 152407*, $3.60.

See also:—
Miscellaneous: Ref. 2094.

* For full title see Ref. 2103.

EDICAL

53 **Solution of the problem of diagnosis by an electronic achine.** N. M. Amosov and E. A. Shkabara, *Automatika*, No. 1, 51, 47-55. (In Russian) English summary: 'The underlying nciple for designing a diagnostic machine is the objectivisa- n of the entire process of establishing the diagnosis. The velopment of such a machine is being carried out along e following lines: (1) Designing a system of pick-ups to obtain jective characteristics of the activity of the organism; (2) eveloping procedures for the automatic interpretation of formation received from the pick-ups; (3) Carrying on statis- al processing of the case history data with aim of revealing e authentic symptoms of disease complexes; (4) Working out e algorithm of the solution of the problem of establishing a agnosis on an electronic machine. At present the problem of agnosis has been programmed and can be solved on the "Ural" ectronic computer, on the basis of an algorithm which has en derived. A relay diagnostic machine has been developed to eck symptoms of various diseases. Algorithms have been mpiled for the interpretation of electrocardiograms on the Ural" electronic computer.'

ILITARY

054 **Advance TTR data handling system supports Nike-Zeus.** . S. Johnson and S. V. Campbell, *Auto. Control*, **15,** July 1961, 2-54. The Nike-Zeus anti-missile missile system being developed or defence against intercontinental ballistic missiles, will use a arget tracking radar (TTR) to obtain highly accurate position ata on the target. This article gives a general account of a igital data system, called Tape and Buffer System, developed y Radiation, Inc., for the transfer of data between the TTR lata processor and an IBM 704.

055 **On the asymptotic behavior of certain one-dimensional lows.** J. H. Giese, *Ordinary Differential Equations Proc.**, 1960, 44-580. The efflux of combustion products from a gun tube is a undamental phenomenon in interior ballistics. To give a com- letely mathematical rigorous account of this process as a non- teady turbulent three-dimensional motion of a chemically eacting viscous heat-conducting fluid would be impossible. How- ever, it is suggested that in the problem of efflux into the tmosphere there is an intuitively evident asymptotic behaviour. Regardless of the original nature of the motion, eventually equilibrium should be achieved, i.e. after the passage of long enough periods of time, arbitrary initial disturbances should attenuate to insignificance. To investigate a question connected with the rate of attentuation Dr W. C. Taylor has suggested considering the asymptotic behaviour of a one-dimensional unsteady isentropic flow in a tube of constant cross-sectional area, closed at one end, open at the other. In this paper, a different approach is employed to confirm Taylor's conjecture about asymptotic behaviour in two particular cases. 3 refs.

2056 **Organization and program of the BMEWS Checkout Data Processor.** A. E. Miller and M. Goldman, *Proc. Eastern Joint Computer Conference*, 1960, 83-96. The Ballistic Missile Early Warning System (BMEWS) Checkout Data Processor (CDP) is thought to be the first medium-size digital computer to perform the real-time, on-line checkout of an entire operational radar detection and processing system. This paper is the first to describe the unique organisation of the BMEWS CDP and the unusual structure of its program. The primary purpose of the CDP is to determine the operability of BMEWS by inserting either a test pattern or a 'realistic' sequence of events into the system and then to evaluate the BMEWS on the basis of its response.

2057 **TARGETEER.** F. M. Tonge, *Commun. ACM*, **4,** May 1961, 236. Very brief description of a routine developed at the Rand Corporation to determine the highest expected target value routing of aircraft through a target complex.

2058 **Application of finite difference methods to problems in two-dimensional hydrodynamics.** R. Grandey, Aeronutronic, *AD-256328*, 26 Jan. 1961, 29 p., $3.60. Research was concerned with the development of a two-dimensional hydrodynamics computation program on the IBM 709 for use in the analysis of non-nuclear warhead design problems. The program, which employs a Lagrangean, triangular mesh, was modified to be compatible with the IBM 709 and associated peripheral equipment. The early expansion of the case of a 105 mm shell was studied. The program allows different time intervals in different parts of the spatial mesh.

2059 **Computer programming for real time, impact prediction and destruct control.** C. E. Black (Ed.), Land-Air Inc., *AD-255329*, 31 March 1961, 59 p., $6.60. The computer program accepts data from three input sources simultaneously: (1) polar coordinates from one radar; (2) direction cosines alpha and beta from a cotar, the foregoing at 20 samples per second; and (3) polar coordinates from a second radar at 8.13 samples per second. The program computes from two input systems: (1) A choice of (a) the combination of cotar angles and radar range, or (b) polar coordinates from the radar alone; and (2) polar coordinates from the second radar. The program respects the primacy of one input system over the other where the operator indicates the primary system. Data from both systems are edited. Position is computed, smoothed velocity components are computed and compared with a tolerance. The complete logic considers the edit results and the results from the various comparisons for choosing input to routines for predicting the location of the missile impact point and for recognising criteria for destroying the missile.

2060 **The mechanism of the transition from deflagration to detonation in high explosives.** C. T. Zovko, Naval Ordnance Labs., *AD-256593*, 14 April 1961, 30 p., $3.60. Experimental results of the study of spontaneous transition from deflagration to detonation indicate that the approach to the problem can be in two stages; the first is the formation of a shock from pressure waves engendered by a confined deflagration, and the second the shock-initiation of detonation. A program for the analytical treatment of the first stage was written for the IBM 704. Two numerical codes have been tested, one based on the so-called q-method and one which avoids amplitude fluctuations inherent in the q-method and thus gives a more realistic representation of a shock wave. Representations of spontaneous shock formation obtained by the two numerical codes and by the analytical treatment are discussed and compared. The numerical methods yield the temperature as a function of time and location during growth of the shock and thus allow a study of simple chemical kinetic models. Introduction of chemical kinetics into the program gives a basis for elucidation of the second stage of the transition problem, namely shock-iniation of detonation. 12 refs.

2061 **Model of a type air defense system.** K. Appel, M. Goldberg et al, University of Michigan, *PB 154159*, July 1959, 29 p., $2.60. Following design of an experimentation with a large computer model of an air-defence system, it became apparent that certain aspects of such systems could be investigated with a less complex and expensive model. A general-type model was designed and programmed in the SOAP II language for the IBM 650. This report contains a brief description of the model and its operation, formulas and their derivations, flow charts, and input and output formats. 3 refs.

See also:—
Technique: Ref. 1915.
Control—General Systems: Ref. 2027.
Engineering, Mechanical: Refs. 2040 and 2043.
Simulation: Refs. 2085*a*, 2085*b*, and 2085*f*.

NUCLEAR

2062 **Application of computing techniques to nuclear physics.** K. A. Redish, *Ordinary Differential Equations Proc.**, 1960, 476-479. This paper describes computations involved in the determination of the forces between nucleons.

2063 **Sur une classe de problèmes aux limites intervenant en physique de réacteurs.** (On a class of boundary problems arising in the physics of reactors.) R. Lattes and J. L. Lions, *Ordinary Differential Equations Proc.**, 1960, 48-88. (In French) This paper presents a systematic method of solving a number of different boundary problems all having the same essential characteristics which occur in nuclear reactor physics. In the first part of the paper the general theory is given. Use is made of procedures in the theory of elliptical boundary problems; definitions are given of all notions introduced and results used are stated without proof. In the second part of the paper, the theory is applied to examples. 6 refs.

2064 **Convergence of the discrete ordinate method for the anisotropic scattering transport equation.** H. B. Keller, *Ordinary Differential Equations Proc.**, 1960, 292-299. This paper gives convergence proofs for the discrete ordinate method for the anisotropic scattering transport equation, which is a form of the linearised Boltzmann integro-differential equation. 3 refs.

* For full title see Ref. 2103.

5 A self-consistent one-group method for the Boltzmann nsport equation in neutronics. L. H. Underhill, *Ordinary fferential Equations Proc.**, 1960, 486-498. This paper cribes the self-consistent one-group method, which is an empt to approach the accuracy of a multi-group solution of neutron transport equation with a computing procedure olving only the solution of a one-group neutron transport uation. With this method, a considerable gain in computing ne can be achieved for some sacrifice of accuracy. 1 ref.

6 The solution of integro-differential equations occurring in clear collision problems. R. A. Buckingham and P. G. Burke, *dinary Differential Equations Proc.**, 1960, 458-475. This per discusses the integro-differential equations which repre- nt a collision between two nuclei, each consisting of a small mber of nucleons (protons and neutrons), and methods of lution. A brief account is given of a program for MERCURY, d results obtained on this computer and on ACE and DEUCE e presented. 21 refs.

7 A special-purpose analogue computer and its use in reactor gineering. W. A. Havranek, *J. Brit. I.R.E.*, **21,** March 1961, 5-234. An account is given of an analogue computer employing number of units whose main use is limited to nuclear reactor mulation, together with basic units similar to those found in rious general purpose computers. It is possible to build up stallations of varying capacity from these units in order to pe with different nuclear reactor design or training problems. 3 refs.

8 On the spectrum of a mono-energetic neutron transport perator. R. van Norton, *Ordinary Differential Equations Proc.**, 960, 603-607. This paper is concerned with the problem of the ransport of mono-energetic neutrons in a homogeneous sphere here the neutrons are scattered with spherical symmetry in the aboratory system, and discusses the spectrum of the transport perator. 5 refs.

9 The BKS system for the Philco-2000 computer. R. B. Smith nd C. H. Hunter, Bettis Atomic Power Lab., *WAPD-TM-233*, April 1961, 64 p., $1.50.

0 FLEER: a two-dimensional triangular mesh diffusion pro- ram for the IBM 704. J. L. Fletcher, J. P. Jewett and E. D. Reilly, Knolls Atomic Power Lab., *KAPL-2086*, 6 May 1960, 0 p., $1.50.

1 LOLA—a multi-dimensional optimization code for the BM 709-7090. M. R. Egan and C. N. Knudsen, Hanford Atomic Products Operation, *HW-68527*, Feb. 1961, 61 p., $1.50.

2 Reference manual for the Bettis Open Shop System (BOSS-2) as used with the Philco-2000. D. E. George, Bettis Atomic Power Lab., *WAPD-TM-269*, April 1961, 58 p., $1.50.

3 Runaway analysis for a gas-cooled reactor. R. A. Becker, Gen. Electric Co., *APEX-585*, April 1961, 89 p., $2.00.

4 TRAC-1. A Monte Carlo Philco-2000 program for the calculation of neutron capture probabilities. H. J. Berwind and J. Spanier, Bettis Atomic Power Lab., *WAPD-TM-229*, March 1961, 41 p., $2.00.

PHYSICS

5 Error analysis for the numerical solution of certain differential equations in gasdynamics. G. Seegmüller, *Ordinary Differential Equations Proc.**, 1960, 312-319. This paper deals with the errors which arise in the numerical solution of initial value problems of the partial differential equations which govern the behaviour of steady, irrotational, isentropic supersonic flows of ideal gases of plane and axial symmetry, and reviews the results of numerical investigations on the PERM computer at the Munich Technical University. 3 refs.

6 FILTER—a topological pattern separation computer program. D. J. Innes, *Proc. Eastern Joint Computer Conference*, 1960, 25-37. A typical six-month experiment on the University of California 72-inch Hydrogen Bubble Chamber yields photographic records of millions of nuclear events. This paper is concerned with a measuring and topological identification system which has been developed to analyse these great volumes of research data. A scanning technique has been proposed which allows rapid recognition, separation and measurement of the photographic records of star type nuclear events. A device known as the Spiral Reader measures background and star type event features impartially, discriminating against non-radial patterns by the geometry of its rotating scanning element. The event measurements are separated from the background measurements by an IBM 704 under the direction of a program called FILTER. This program exploits the observation that if a segment of a circular arc is rotated about a point on that arc, intercepts occur at regular intervals along a radius to the point at constant angular intervals of the rotation azimuth. The separated nuclear event measurements are subsequently reconstructed on a cathode ray tube display. 5 refs.

7 The numerical solution of the differential equations governing the motion of viscous fluid between two rotating discs. G. N. Lance and M. H. Rogers, *Ordinary Differential Equations Proc.**, 1960, 213-221. After describing a physical problem relating to the motion of viscous fluid between two rotating discs, a method for the numerical solution of the differential equations governing the motion is presented. The method employs two techniques which have been found extremely useful in the solution of systems of ordinary but nonlinear differential equations involved in such physical problems. The first technique is Merson's modification of the Runge-Kutta method, which provides a means of choosing the step length automatically, and the second is Warner's method for the solution of two-point boundary value problems. 6 refs.

8 The numerical solution of the singular integral equation for the charge distribution on a flat rectangular lamina. B. Noble, *Ordinary Differential Equations Proc.**, 1960, 530-543. This paper describes the use of the variational method for the numerical solution of the singular integral equation for the charge distribution on a flat rectangular lamina. The equation which is treated is

$$\int_{-a}^{a}\int_{-b}^{b} \frac{f(\xi,\eta)\,d\xi\,d\eta}{[(x-\xi)^2+(y-\eta)^2]^{\frac{1}{2}}} = 1$$

where $f(\xi,\eta)$ is the total (i.e. two-sided) charge density at a point (ξ,η) on a flat perfectly-conducting rectangular lamina, or plate of zero thickness, lying in $z=0$, $-a \leqq x \leqq a$, $-b \leqq y \leqq b$, and at unit potential. Numerical results are discussed and the application of the equation to other problems is indicated. 5 refs.

9 Solution of the Boltzmann Hilbert integral equation. Propagation of sound in a rarefied gas. C. L. Pekeris, Z. Alterman and L. Finkelstein, *Ordinary Differential Equations Proc.**, 1960, 388-398. 5 refs.

0 Solution of integro-differential equations arising in the theory of atomic scattering. R. McCarroll, *Ordinary Differential Equations Proc.**, 1960, 258-264. The excitation of atoms and molecules under the impact of electrons or other atomic particles is a process which can be described, according to the laws of quantum mechanics, by a set of n coupled integro-differential equations. Two methods of solution are described, the second reformulating the problem in terms of a set of integral equations. 3 refs.

1 A computer treatment of radiative transfer on a cubic lattice (plane sources). W. H. Richardson and R. W. Preisendorfer, University of California, *PB 154052*, June 1960, 79 p., $7.60. Between two extreme methods of analysis lies a large, relatively unexplored collection of analytic techniques of intermediate delicacy and incisiveness which may be used to coax a store of answers from the radiative transfer equation. The purpose of this report is to study the numerical application of one such technique. This technique is called *discrete-space radiative transfer theory*. 10 refs.

2 A preliminary digital computer program (FORTRAN) for three-dimensional heat conduction. W. M. Burley, Naval Ordnance Lab., White Oak, *AD-255722*, 30 Jan. 1961, 25 p., $2.60. A FORTRAN coded program was developed to calculate temperature distributions due to transient or steady state conduction heat transfer in one, two, or three-dimensional systems. Calculations in the program are based on a finite difference solution of the conduction equation in cylindrical coordinates. The system may be made of a group of different materials and may have distributed sources of heat. Applicability of a given problem to the program depends primarily on the boundary conditions available in the program. The program is written to provide for a choice of surface temperature or surface conductance for the boundary condition on the cylindrical surface when the conductance subroutine is included.

* For full title see Ref. 2103.

MULATION

083 **Generalized simulation of Post Office systems.** R. C. righam and P. D. Burgess, *J. Assn. Computing Mchy.*, **8,** April 961, 252-259. This paper describes an IBM 704 program which mulates mail processing systems within any United States Post ffice. Such systems can be represented by a connection of basic rocessing operations, of which there are only four different ypes. Any desired connection is possible, and therefore any size ostal system can be simulated. The basic processing calculations re given and the program flow chart is briefly discussed. Some f the applications and results are indicated. 5 refs.

084 **Leviathan studies.** S. C. Rome, *Commun. ACM,* **4,** April 961, 194. Brief account of the Leviathan studies at System Development Corporation, which are investigations into how eople operate in large social organisations. Programs are being vritten to simulate on the IBM 709 the operations of large social roups. 2 refs.

085 **Simulation Council Newsletter.** J. McLeod (Ed.), *Instr. & Control Systems,* **34,** July 1961, 1271, 1272, 1274, 1276-1278, 1280, 1281. The main items are as follows:

a. **Effectiveness studies of manned airborne weapon systems by digital simulation.** P. H. Kennard, p. 1271-1272. Account of SMITE (Simulation Model of Interceptor Terminal Effectiveness) used by Hughes Aircraft Company to simulate on IBM 7090, manned interceptor bomber engagements.

b. **Tour of the Q-7 SAGE Facility.** S. Zasloff, p. 1272. Introduction to the SAGE computer system.

c. **Tour of the Automated Teaching Facility.** H. F. Silberman, p. 1272, 1274. Introduction to System Development Corporation's research in computer-based teaching machines.

d. **A preliminary study of fixed-bed tubular catalytic reactor dynamics on an analog computer.** H. D. Yoo, p. 1274, 1276.

e. **Computational machine analysis of the transient response of nonlinear circuits.** P. A. Honkanen, p. 1276-1277. Circuit analysis by analogue and digital computers is compared and an analogue method of analysis is discussed.

f. **Simulation for display system design.** W. E. Smith, p. 1277-1278. Account of display system simulation to measure changes in operator performance resulting from changes in SAGE display system design.

g. **Analog techniques.** T. C. Anderson, p. 1278, 1280. Discussion of techniques for obtaining a special gain amplifier.

(Items *a* to *c* are summaries of talks given at the Western Simulation Council meeting of 12 January 1961, and items *d* to *f* are summaries of talks given at the Eastern Simulation Council meeting of 20 February 1961.)

2086 **Digital methods of system simulation at the component level.** G. E. Martin and T. F. Droege, M.I.T., *AD-221503 (PB 155571),* June 1958, 110 p., $9.10. A study was made of the feasibility of simulating systems on a digital computer by means of an executive routine which monitors arbitrary subroutines each of which simulate the characteristics of a particular component. A compiling and executive routine (MADCAP) and several subroutines were written. Using these routines, programming for system simulation is essentially reduced to the identification of outputs of components with inputs of others as shown on a block diagram of the system. Several positional servomechanisms were successfully simulated. 16 refs.

2087 **Techniques for evaluating operator loading in man-machine systems. A model for digital simulation of one and two-operator man-machine systems.** A. I. Siegel, J. J. Wolf and K. Crain, Applied Psychological Services, *AD-255518,* March 1961, 96 p., $9.10. The extension of a model, which had as its aim the prediction of the effectiveness of uni-operator man-machine systems, to simulate two-operator systems is described. The two-operator model may also be employed for evaluating uni-operator systems. A high speed digital computer is used to calculate and record simulated operator performance data for every action of each operator and to yield an indication of system effectiveness on the basis of these simulations. After development, the model was applied to the simulation of in-flight refueling of an F8U receiver aircraft by an A4D tanker aircraft. The manoeuvres and actions of the F8U pilot during approach and probe insertion as well as the concomitant actions of the tanker aircraft pilot during this flight task were simulated. The results from this initial application of the model, appear to conform with reality and are generally reasonable. 13 refs.

TRANSPORT

2088 **Marine fleet (selected articles).** Aerospace Technical Intelligence Center, Wright-Patterson Air Force Base, *AD-255409,* 21 Dec. 1960, 27 p., $2.60. Contents include 'Possibilities of employing electronic digital computers in ship handling.'

MISCELLANEOUS

2089 **Automated teaching.** E. F. Cooley, *Computers & Automn.,* **10,** July 1961, 10-12. General survey of work on automated teaching, including the use of computers and automated teaching of computer programming.

2090 **Computer-feasible method for handling incomplete data in regression analysis.** J. E. Walsh, *J. Assn. Computing Mchy.,* **8,** April 1961, 201-211. The data ordinarily available for determining the regression function of a variable to be estimated on the variables used for the estimation consist of a number of multivariate observations, where each observation contains values for the estimation variables and the corresponding value for the estimated variable. However, in many situations involving biological, medical or other data, some of the values for the variables are missing. This can happen among the observations used in determining the regression function and also in the application of the regression function for estimation purposes. This paper presents a method for handling these two problems. The underlying procedure involves the estimation of the missing value for an estimation variable from its regression function on the estimation variables with known values. 4 refs.

2091 **A computer for weather data acquisition.** P. Meissner, J. A. Cunningham and C. A. Kettering, *Proc. Eastern Joint Computer Conference,* 1960, 57-66. This paper gives an account of data processing equipment for the recording, pre-processing and transmission of weather data, which has been developed by the National Bureau of Standards and the U.S. Weather Bureau as a prototype in the development of automatic weather stations to meet the requirements of modern aircraft. A description is given of quantities to be measured (such as atmospheric transmissivity, wind speed, temperature, pressure, cloud height, approach light contact height and runway visual range) and the associated instruments. An account is then given of the specialised digital computer system—the AMOS IV System—which has been developed and of its operation.

2092 **Intégation par une méthode de différence des équations intrinsèques d'un fil raide pesant, avec conditions aux limites. Application à la pose d'une conduite.** (Integration by a difference method of intrinsic equations of a rigid heavy wire, with boundary conditions. Application to the laying of a pipe.) J. Carteron and A. Meallier, *Ordinary Differential Equations Proc.*,* 1960, 151-161. (In French) This paper describes work undertaken in connection with studies concerned with the laying of a pipe in the Mediterranean. The object is to obtain for different cases the curve of equilibrium of the pipe as it is layed from a ship, so as to permit choice between different possibilities in endeavouring, for example, to avoid dangerous constraints. In order to find the curve of equilibrium, the pipe is simulated by a rigid heavy wire.

2093 **An investigation of real-time solution of the transportation problem.** R. Totschek and R. C. Wood, *J. Assn. Computing Mchy.,* **8,** April 1961, 230-239. This paper reports an investigation of methods for solving the transportation problem within the framework of a cyclic real-time digital computer program system (the programs being written for the AN/FSQ-7, a single-address, stored-program von Neumann computer). Two techniques for obtaining a basic feasible solution, the Northwest Corner Rule and a modification of Vogel's Approximation Method, are considered. The solution is then iterated using the Dual Theorem. A statistical analysis is made of the solution times of each method for different matrix dimensions. Consideration is given to methods for truncating the process, and recommendations are made. The use of Vogel's Approximation Method is shown to yield significantly faster solution times. 12 refs.

2094 **Redundancy exploitation in the computer solution of double-crostics.** E. S. Spiegelthal, *Proc. Eastern Joint Computer Conference,* 1960, 39-56. This paper discusses, with examples, the solution on an IBM 704 of double-crostics (puzzles in which the individual letters in answers to crossword-type definitions have to be put in specified places in a sentence). This study was made because such puzzles exhibit the salient features of the problem of exploiting, by non-algorithmic means, the redundancy inherent in structured-data problems, particularly those problems,

* For full title see Ref. 2103.

:chanical translation for example, in which the source data is a tural language. The computer is supplied with a list of possible swers for each definition or clue and also with a dictionary words for use in filling in the sentence. In addition four tables e provided: a frequency-ordered list of the hundred most fre-ently used words; a frequency-ordered list of letters; a :quency-ordered list of two-letter combinations; and an un-dered list of three-letter combinations.

095 **A system for generating "pronounceable" names using a mputer.** A. L. Leiner and W. W. Youden, *J. Assn. Computing chy.*, **8,** Jan. 1961, 97-103. An account is given of a computer ocedure for generating four-letter pronounceable names, the oject being to satisfy the need, in the detailed logical design of e NBS PILOT, for a set of names for the more than 15,000 ternal signals generated throughout the machine. 2 refs.

096 **Engineering applications of analog computers.** L. T. ryant, M. J. Janicke et al, Argonne National Lab., *ANL-6319,* eb. 1961, 48 p., $1.25.

097 **The fairing of ship lines on a high-speed computer.** F. heilheimer and W. Starkweather, David Taylor Model Basin, *D-249706 (PB 154133),* Jan. 1961, 23 p., $2.60. Methods for sing a digital computer to determine ship lines are presented. . is assumed that the offsets of a small number of points were ken from a preliminary design, and that it is desired to com-ute the offsets of an arbitrary large number of points on the ip's surface. Procedures for using a computer for the solution f this problem are described. Special emphasis is placed on the etection, by a computational criterion, of unwanted fluctuations nd the correction of such fluctuations if they should occur. The ethod also includes a special procedure which takes care that ose portions which are straight in the preliminary design emain straight in the final form. 5 refs.

098 **Improvement, evaluation, and extension of capabilities of neteorological simulation (Dallas Tower Program).** W. H. Clayton, Texas A. & M. Research Foundation, *AD-255345,* Jan. 961, 24 p., $2.60. Quarterly report for 16 Sept.-15 Dec. 1960, he contents including instrumentation and review of general urpose analogue computer study.

2099 **Questionnaire design and machine processing systems for uniform material comparison studies.** J. W. Hamblen, Kentucky Research Foundation, *PB 171298,* Jan. 1961, 49 p., $1.25. The REDI-CODED format for survey questionnaires is introduced. General comparisons are made among manual, sorter, account-ing machines, statistical sorter, small computer, medium sized computer, and large scale computer systems with regard to costs and efficiency in processing survey data. Stratified systematic sampling with proportional allocation is recommended for com-parison studies of U.S.A.F. uniform materials. 7 refs.

2100 **Research study. Special cases of simulating the energy budget of the earth/air interface.** J. F. Appleby and L. Fujikado, Army Electronic Proving Ground, *AD-255055,* Oct. 1960, 162 p., $5.60. A model of the heat budget of the earth/air interface was mechanised on a PACE 31R analogue computer. Results are presented for two test cases, one using constants which assume the non-unity of the ratio of eddy diffusivities for heat and water vapour, and the other using constants which assume the ratio to be one. For both cases changing boundary conditions with time were generated by function generators.

2101 **Type II interim technical report for the Automatic Map Compilation System.** S. Bertram and H. M. Beckwith, Thompson Ramo Wooldridge Inc., *AD-255619,* 7 March 1961, 43 p., $5.60. The Automatic Map Compilation System utilises a small digital computer which directs an analogue system to the indicated homologous points on a stereo diapositive pair. An analogue scan, with associated correlation equipment, operates to measure the height error, thereby providing a basis for extrapolation to the next point. The detail terrain data is used to produce an orthophoto and the altitude measurement is used to produce a drop-line chart from which the contour lines can be drawn. The system analysis, mechanical design, and computer program have revealed no serious problems.

See also:—
Simulation: Ref. 2085*c*.

BOOKS

2102 **Proceedings of the Eastern Joint Computer Conference, 1960.** x+342 pages, $3.00. Contains the papers presented at the Joint IRE-AIEE-ACM Computer Conference, New York, 13 to 15 December 1960. The papers are individually abstracted in this issue under Refs. 1809, 1812, 1815, 1816, 1818, 1819, 1833, 1901, 1907, 1910, 1923 to 1925, 1928, 1929, 1937, 1940, 1988, 1989, 1992, 1994, 2027, 2034, 2039, 2056, 2076, 2091 and 2094.

2103 **Symposium on the numerical treatment of ordinary differential equations, integral and integro-differential equations. Proceedings of the Rome Symposium (20-24 September 1960) organized by the Provisional International Computation Centre.** Birkhauser Verlag, 1960, 679 pages, Fr. 35.00, DM 35.00. The papers contained in this volume are individually abstracted in this issue under Refs. 1807, 1843, 1845 to 1847, 1849 to 1874, 1876 to 1881, 1900, 1939, 2014, 2033, 2042, 2055, 2062 to 2066, 2068, 2075, 2077 to 2080 and 2092.